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CLUSTER ANALYSIS IN PHENOLOGY: SPRING MIGRATION OF BIRDS

Zdeněk HUBÁLEK

Received January 25, 1982

Abstract. The spring arrival or migration of 25 species of birds in Czechoslovakia during 16 seasons was subjected to a cluster analysis, based on the correlation of the phenological data between various species. Several distinct phenological groups — “spring migrons” — resulted of those bird species significantly correlated in their spring migration chronological pattern, viz.: (A) *Sturnus vulgaris*, *Alauda arvensis*, *Larus ridibundus*, *Corvus frugilegus* and *Vanellus vanellus*; (B) *Turdus philomelos* and *Fringilla coelebs*; (C) *Erithacus rubecula*, *Hirundo rustica*, *Delichon urbica*, *Phylloscopus trochilus*, *P. collybita*, *Sylvia atricapilla* and *Acrocephalus schoenobaenus*; (D) *Phylloscopus sibilatrix*, *Luscinia megarhynchos*, *Anthus trivialis*, *Hippolais icterina* and *Cuculus canorus*; (E) *Sylvia curruca* and *Apus apus*, while remaining species of birds were arranged as singletons. However, *Phoenicurus ochruros* showed some relationship to migron A, *Jynx torquilla* to migron E, and *Motacilla alba* was partly related with *Serinus serinus*. The composition and a possible causality of the migrons is briefly discussed.

INTRODUCTION

Phenology is an ancient branch of ornithology, and most of its experience had been accumulated in the past by field ornithologists or meteorologists doing it as a hobby (on the territory of Czechoslovakia: Fritsch, 1855, 1867; Niessl, 1881—1907; Čapek, 1888, 1890; Rzehak, 1895, 1896; Zdobnitzky, 1912; Zítek, 1953—1964; etc.). This may be the reason why phenology stands now outside the main interest of the majority of professional ornithologists. It is a pity because the bird phenology might solve some questions of bird migration and, moreover, it also could have an effect on the meteorological prognostic which still needs more data to approach a greater efficiency and precision.

Unfortunately, the use of information from an immense body of phenological data is far from being exhaustive and is mostly restricted to simple calculations of the mean date and the range of arrival (or departure) of a species within a territory. Some authors analysed the phenology of individual bird species in more details, with respect to geographic location, altitude, or meteorological situation (e. g., Rzehak, 1896, Pikula, 1972, 1974; Beklová, 1975). However, much more study is needed to show relationships of the phenological data to particular climatic factors, and to reveal correlations among the phenological data themselves. It is hoped that some sophisticated techniques such as cluster analysis or factor analysis, markedly developed in the last two decades, may represent one approach to this problem.

In this study, correlations between the bird species', related to their spring phenological data, have been analysed by clustering.

METHODS

The phenological observations were carried out during 16 spring seasons in the years 1965 to 1981. The observation localities included in 1970 to 1981 Břeclav (48° 46' N, 16° 54' E; 160 m a. s. l.) and Valtice (48° 44' N, 16° 46' E; 195 m a. s. l.), in 1967 to 1969 Pardubice (50° 02' N, 15° 48' E; 220 m a. s. l.), and in 1965 Valašské Meziříčí (49° 29' N, 17° 58' E; 310 m a. s. l.). Twenty-five species of birds were followed and I recorded the days of either the first appearance of the birds in spring (most species), the first birds in the city (Black-headed Gull), the start of a marked migration (Chaffinch), or a considerable (ca. a half) decrease of the wintering population as based on quantitative observations of the morning passage of the birds from their winter roosts (Rook). It has been sometimes impossible to record satisfactorily every bird species each year, and there are thus some gaps in the data.

The calendar data were then transformed into sequential numbers (Table 1), and Pearson's product-moment correlation coefficient r was calculated for each pair (total 300) of the birds' species on the basis of these phenological data. The values of the correlation coefficient were subjected to two techniques of cluster analysis: (i) half-linkage clustering (Hubálek, 1978); (ii) average-linkage clustering, UPGMA variant, using the transforms $\cos^{-1} r$ to obey metric axioms (Sneath and Sokal, 1973). In the half-linkage method, only significant ($P < 0.05$; Fisher and Yates,

Table 1. Transformation of the calendar data into sequential numbers

| Month: | February | March | April | May |
|--------|----------|-------|-------|-----|
| Day | | | | |
| 1 | 32 | 60 | 91 | 121 |
| 2 | 33 | 61 | 92 | 122 |
| 3 | 34 | 62 | 93 | 123 |
| 4 | 35 | 63 | 94 | 124 |
| 5 | 36 | 64 | 95 | 125 |
| 6 | 37 | 65 | 96 | 126 |
| 7 | 38 | 66 | 97 | 127 |
| 8 | 39 | 67 | 98 | 128 |
| 9 | 40 | 68 | 99 | 129 |
| 10 | 41 | 69 | 100 | 130 |
| 11 | 42 | 70 | 101 | 131 |
| 12 | 43 | 71 | 102 | 132 |
| 13 | 44 | 72 | 103 | 133 |
| 14 | 45 | 73 | 104 | 134 |
| 15 | 46 | 74 | 105 | 135 |
| 16 | 47 | 75 | 106 | 136 |
| 17 | 48 | 76 | 107 | 137 |
| 18 | 49 | 77 | 108 | 138 |
| 19 | 50 | 78 | 109 | 139 |
| 20 | 51 | 79 | 110 | 140 |
| 21 | 52 | 80 | 111 | 141 |
| 22 | 53 | 81 | 112 | 142 |
| 23 | 54 | 82 | 113 | 143 |
| 24 | 55 | 83 | 114 | 144 |
| 25 | 56 | 84 | 115 | 145 |
| 26 | 57 | 85 | 116 | 146 |
| 27 | 58 | 86 | 117 | 147 |
| 28 | 59 | 87 | 118 | 148 |
| 29 | 60 | 88 | 119 | 149 |
| 30 | — | 89 | 120 | 150 |
| 31 | — | 90 | — | 151 |

Remark: In leap-years, the sequential numbers s were corrected as $s + 1$, starting from March 1.

Table 2. Spring arrival of the first birds of particular species, expressed in the sequential days' numbers

| Year: | '65 | '67 | '68 | '69 | '70 | '71 | '72 | '73 | '74 | '75 | '76 | '77 | '78 | '79 | '80 | '81 |
|--|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| Species | | | | | | | | | | | | | | | | |
| <i>Sturnus vulgaris</i> | 76 | 57 | 69 | 69 | 73 | 67 | 58 | 41 | 48 | 68 | 68 | 56 | ND | 70 | ND | 58 |
| <i>Alauda arvensis</i> | 76 | 56 | 68 | 75 | 73 | 76 | ND | 55 | 47 | 70 | 76 | ND | ND | 77 | ND | 65 |
| <i>Larus ridibundus</i> ¹⁾ | 80 | 62 | 71 | 71 | 77 | 78 | ND | 72 | 61 | 62 | 66 | 64 | ND | 72 | 82 | 66 |
| <i>Corvus frugilegus</i> ²⁾ | 74 | 66 | 74 | 72 | 77 | 76 | ND | 73 | 65 | 67 | 74 | 65 | 66 | 72 | 71 | 67 |
| <i>Vanellus vanellus</i> | 76 | 70 | 77 | 80 | 84 | 79 | ND | 69 | 65 | ND | 68 | ND | ND | 70 | 74 | 67 |
| <i>Turdus philomelos</i> | ND | 68 | 78 | 73 | ND | 79 | ND | 76 | 74 | 66 | 86 | 78 | 86 | 77 | 69 | 79 |
| <i>Fringilla coelebs</i> ³⁾ | 89 | 65 | 71 | ND | 73 | 79 | ND | ND | 75 | ND | 87 | 78 | 87 | 77 | ND | ND |
| <i>Motacilla alba</i> | 80 | 83 | 86 | 81 | 71 | 77 | ND | 81 | 75 | 88 | 87 | ND | ND | 70 | ND | 78 |
| <i>Eritacus rubecula</i> | ND | 84 | 80 | 73 | 92 | 79 | ND | 89 | 75 | 70 | 87 | ND | ND | 84 | ND | ND |
| <i>Phylloscopus collybita</i> | 93 | 84 | 85 | ND | 92 | 79 | ND | 83 | 82 | 80 | 87 | ND | 90 | 84 | 90 | 83 |
| <i>Phoenicurus ochruros</i> | 80 | 91 | 84 | 95 | 91 | 95 | 96 | 84 | 79 | 72 | 89 | 72 | 87 | 92 | 88 | 83 |
| <i>Serinus serinus</i> | 107 | 100 | 90 | 98 | 87 | 86 | 102 | 97 | 88 | 95 | 87 | 87 | 92 | 82 | 97 | 87 |
| <i>Phylloscopus trochilus</i> | 109 | 106 | 95 | 106 | ND | 100 | ND | 113 | 97 | 95 | 109 | ND | 98 | 104 | ND | 107 |
| <i>Hirundo rustica</i> | 97 | 103 | 102 | 97 | 109 | 97 | ND | 113 | 97 | 95 | 106 | 111 | 111 | ND | ND | ND |
| <i>Sylvia atricapilla</i> | ND | 109 | ND | ND | 117 | 100 | 104 | 97 | 97 | 98 | 109 | ND | ND | 104 | 122 | 117 |
| <i>Sylvia curruca</i> | ND | 109 | 107 | 115 | 115 | 108 | 104 | 98 | 117 | 102 | 114 | ND | ND | 116 | ND | 121 |
| <i>Aeronauphalus schoenobaenus</i> | ND | 109 | 112 | ND | 121 | 100 | ND | 113 | 110 | 102 | 109 | ND | ND | ND | ND | 119 |
| <i>Jynx torquilla</i> | 121 | 109 | 117 | 120 | 108 | 112 | 100 | ND | 117 | 109 | 109 | ND | ND | ND | ND | ND |
| <i>Delichon urbica</i> | 121 | ND | ND | ND | 121 | 105 | ND | 120 | 99 | 102 | 117 | ND | 120 | 116 | 104 | 113 |
| <i>Phylloscopus sibilatrix</i> | ND | 110 | 109 | ND | ND | ND | 123 | ND | 117 | 113 | 126 | ND | ND | 104 | ND | 119 |
| <i>Anthus trivialis</i> | ND | 110 | 110 | 116 | 121 | ND | 119 | 118 | 117 | 116 | ND | ND | 117 | ND | ND | 119 |
| <i>Cuculus canorus</i> | 115 | 109 | 112 | 116 | 121 | ND | 118 | 118 | 110 | 120 | 126 | ND | 117 | ND | ND | 110 |
| <i>Luscinia megarhynchos</i> | ND | 111 | 111 | ND | 127 | 128 | 123 | 128 | 117 | 113 | ND | ND | ND | ND | 119 | 117 |
| <i>Apus apus</i> | 134 | 121 | 112 | 119 | 121 | 128 | 120 | 120 | 127 | 116 | 125 | ND | 119 | 125 | 122 | 129 |
| <i>Hippolais icterina</i> | ND | ND | 111 | 126 | ND | ND | 139 | 137 | 121 | 124 | 126 | ND | 125 | ND | ND | 135 |

ND, not done

1) the first birds appearing in the city

2) a marked decrease (ca. a half) of the wintering population

3) the start of a marked migration.

1963) correlation coefficients were taken into the analysis. All calculations were carried out on the pocket calculator SR-51-II (Texas Instruments) equipped with a basic statistical routine including correlation.

RESULTS

Observation data are arranged in Table 2, and they yield the following statistical phenological values in particular birds' species (arithmetic mean of sequential numbers \pm sample standard deviation; mean calendar date, minimum and maximum calendar date recorded):

Starling, *Sturnus vulgaris* L.: 62.7 ± 10.0 ; 4 III. (10. II.—17. III.)
Skylark, *Alauda arvensis* L.: 67.4 ± 9.8 ; 8. III. (16. II.—18. III.)
Black-headed Gull, *Larus ridibundus* L.: 68.9 ± 6.5 ; 10. III. (2.—21. III.)
Rook, *Corvus frugilegus* L.: 70.6 ± 4.2 ; 12. III. (6.—18. III.)
Lapwing, *Vanellus vanellus* (L.): 71.7 ± 9.5 ; 13. III. (16. II.—25. III.)
Song Thrush, *Turdus philomelos* Brehm: 76.1 ± 6.1 ; 17. III. (7.—27. III.)
Chaffinch, *Fringilla coelebs* L.: 78.1 ± 7.7 ; 19. III. (6.—30. III.)
White Wagtail, *Motacilla alba* L.: 79.7 ± 5.9 ; 21. III. (11.—29. III.)
Robin, *Erithacus rubecula* (L.): 81.3 ± 7.2 ; 22. III. (11. III.—2. IV.)
Chiffchaff, *Phylloscopus collybita* (Vieillot): 85.5 ± 4.5 ; 27. III. (20. III.—3. IV.)
Black Redstart, *Phoenicurus ochruros* (Gmelin): 86.1 ± 7.6 ; 27. III. (13. III.—6. IV.)
Serin, *Serinus serinus* (L.): 92.6 ± 7.0 ; 3. IV. (23. III.—17. IV.)
Willow Warbler, *Phylloscopus trochilus* (L.): 103.2 ± 6.1 ; 13. IV. (5.—23. IV.)
Swallow, *Hirundo rustica* L.: 103.4 ± 6.7 ; 13. IV. (5.—23. IV.)
Blackcap, *Sylvia atricapilla* (L.): 106.7 ± 8.8 ; 17. IV. (7.—27. IV.)
Lesser Whitethroat, *Sylvia curruca* (L.): 110.5 ± 6.9 ; 20. IV. (8. IV.—1. V.)
Sedge Warbler, *Acrocephalus schoenobaenus* (L.): 110.6 ± 6.9 ; 21. IV. (10. IV.—1. V.)
Wryneck, *Jynx torquilla* L.: 112.2 ± 6.5 ; 22. IV. (10. IV.—1. V.)
House Martin, *Delichon urbica* (L.): 112.5 ± 8.4 ; 23. IV. (9. IV.—1. V.)
Wood Warbler, *Phylloscopus sibilatrix* (Bechstein): 115.1 ± 7.5 ; 25. IV. (14. IV.—6. V.)
Tree Pipit, *Anthus trivialis* (L.): 116.0 ± 3.7 ; 26. IV. (20. IV.—1. V.)
Cuckoo, *Cuculus canorus* L.: 116.0 ± 5.1 ; 26. IV. (19. IV.—6. V.)
Nightingale, *Luscinia megarhynchos* Brehm: 119.4 ± 6.8 ; 29. IV. (21. IV.—8. V.)
Common Swift, *Apus apus* (L.): 122.5 ± 5.6 ; 3. V. (22. IV.—14. V.)
Icterine Warbler, *Hippolais icterina* (Vieillot): 127.1 ± 8.8 ; 7. V. (21. IV.—19. V.)

Table 3 shows a matrix of the correlation coefficients among the 300 pairs of 25 bird species, calculated from the basic data of Table 2. The right-upper half of Table 3 is a shaded representation ("trellis diagram") of the relationships between the pairs of species, based on the values of correlation coefficients. A more instructive evaluation of the relationships is possible by inspecting dendrograms of Fig. 1 (half-linkage technique) and Fig. 2 (average-linkage technique) which represent the results of cluster analysis of the coefficients. The half-linkage clustering is more rigorous in that it admits only significant coefficients to be taken into the analysis and thus only the phenologically markedly correlated species of birds form one cluster. Six clusters (phenological groups of birds) and five singletons were formed by this technique:

Cluster 1: Starling, Skylark, Black-headed Gull, Rook, Lapwing.

Cluster 2: Song Thrush, Chaffinch.

Cluster 3: Robin, Swallow, House Martin, Willow Warbler.

Table 3. Matrix of Pearson product-moment correlation coefficients (r_{1000}) among 25 species of birds based on the timing of their spring migration. Remarks: The coefficient values in italics are significant ($P < 0.05$). For abbreviations of the species' names, cf. Results. "NC", no comparison (a low number of pair-wise comparable records between the species).

| Spp | Sv | Aa | Vv | Lr | Cf | Po | Fc | Tp | Er | Du | Hr | Pt | Pc | Sa | As | Ps | Lm | Hi | At | Cc | Sc | Aa | Jt | Ss | Ma |
|--------------|-------------|-------------|-------------|------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|------------|------------|----|
| <i>Svul</i> | | | | | | | | | | | | | | | | | | | | | | | | | |
| <i>Aary</i> | <i>884</i> | | | | | | | | | | | | | | | | | | | | | | | | |
| <i>Vvan</i> | <i>667</i> | <i>702</i> | | | | | | | | | | | | | | | | | | | | | | | |
| <i>Lrid</i> | <i>503</i> | <i>607</i> | <i>657</i> | | | | | | | | | | | | | | | | | | | | | | |
| <i>Ctru</i> | <i>531</i> | <i>654</i> | <i>757</i> | <i>822</i> | | | | | | | | | | | | | | | | | | | | | |
| <i>Pach</i> | <i>208</i> | <i>344</i> | <i>580</i> | <i>398</i> | <i>539</i> | | | | | | | | | | | | | | | | | | | | |
| <i>Fcoe</i> | <i>421</i> | <i>570</i> | <i>29</i> | <i>394</i> | <i>152</i> | <i>165</i> | | | | | | | | | | | | | | | | | | | |
| <i>Tphi</i> | <i>107</i> | <i>378</i> | <i>0</i> | <i>460</i> | <i>235</i> | <i>189</i> | <i>937</i> | | | | | | | | | | | | | | | | | | |
| <i>Erub</i> | <i>-87</i> | <i>35</i> | <i>264</i> | <i>428</i> | <i>536</i> | <i>405</i> | <i>78</i> | <i>551</i> | | | | | | | | | | | | | | | | | |
| <i>Durb</i> | <i>241</i> | <i>419</i> | <i>523</i> | <i>653</i> | <i>436</i> | <i>309</i> | <i>452</i> | <i>698</i> | <i>945</i> | | | | | | | | | | | | | | | | |
| <i>Hrus</i> | <i>-438</i> | <i>-2.9</i> | <i>105</i> | <i>-46</i> | <i>-77</i> | <i>33</i> | <i>-49</i> | <i>470</i> | <i>931</i> | <i>735</i> | | | | | | | | | | | | | | | |
| <i>Ptro</i> | <i>206</i> | <i>61</i> | <i>170</i> | <i>291</i> | <i>320</i> | <i>294</i> | <i>337</i> | <i>153</i> | <i>723</i> | <i>724</i> | <i>408</i> | | | | | | | | | | | | | | |
| <i>Pcal</i> | <i>483</i> | <i>260</i> | <i>425</i> | <i>330</i> | <i>281</i> | <i>134</i> | <i>429</i> | <i>318</i> | <i>756</i> | <i>604</i> | <i>379</i> | <i>304</i> | | | | | | | | | | | | | |
| <i>Satr</i> | <i>422</i> | <i>185</i> | <i>457</i> | <i>-63</i> | <i>150</i> | <i>27</i> | <i>-169</i> | <i>8</i> | <i>665</i> | <i>252</i> | <i>466</i> | <i>415</i> | <i>773</i> | | | | | | | | | | | | |
| <i>A sch</i> | <i>-97</i> | <i>-157</i> | <i>95</i> | <i>150</i> | <i>101</i> | <i>91</i> | <i>-286</i> | <i>285</i> | <i>727</i> | <i>662</i> | <i>722</i> | <i>457</i> | <i>737</i> | <i>707</i> | | | | | | | | | | | |
| <i>P sib</i> | <i>307</i> | <i>-55</i> | <i>-343</i> | <i>-43</i> | <i>-18</i> | <i>89</i> | <i>664</i> | <i>505</i> | <i>94</i> | <i>72</i> | <i>200</i> | <i>380</i> | <i>246</i> | <i>220</i> | <i>190</i> | | | | | | | | | | |
| <i>L meg</i> | <i>132</i> | <i>238</i> | <i>312</i> | <i>722</i> | <i>665</i> | <i>490</i> | <i>752</i> | <i>453</i> | <i>54</i> | <i>636</i> | <i>386</i> | <i>476</i> | <i>132</i> | <i>-88</i> | <i>122</i> | <i>978</i> | | | | | | | | | |
| <i>H ict</i> | <i>-490</i> | <i>134</i> | <i>51</i> | <i>111</i> | <i>91</i> | <i>339</i> | NC | <i>55</i> | <i>409</i> | <i>593</i> | <i>491</i> | <i>792</i> | <i>-126</i> | <i>312</i> | <i>383</i> | <i>711</i> | <i>815</i> | | | | | | | | |
| <i>A tri</i> | <i>-84</i> | <i>121</i> | <i>26</i> | <i>417</i> | <i>264</i> | <i>116</i> | <i>524</i> | <i>233</i> | <i>250</i> | <i>624</i> | <i>227</i> | <i>187</i> | <i>368</i> | <i>103</i> | <i>433</i> | <i>915</i> | <i>366</i> | <i>870</i> | | | | | | | |
| <i>C can</i> | <i>327</i> | <i>587</i> | <i>360</i> | <i>254</i> | <i>595</i> | <i>140</i> | <i>574</i> | <i>360</i> | <i>316</i> | <i>363</i> | <i>257</i> | <i>201</i> | <i>298</i> | <i>-6</i> | <i>-121</i> | <i>613</i> | <i>618</i> | <i>198</i> | <i>741</i> | | | | | | |
| <i>S cur</i> | <i>294</i> | <i>180</i> | <i>-214</i> | <i>-70</i> | <i>-141</i> | <i>153</i> | <i>347</i> | <i>346</i> | <i>26</i> | <i>24</i> | <i>-233</i> | <i>42</i> | <i>332</i> | <i>608</i> | <i>476</i> | <i>73</i> | <i>-145</i> | <i>-155</i> | <i>65</i> | <i>-246</i> | | | | | |
| <i>Aapu</i> | <i>63</i> | <i>112</i> | <i>-272</i> | <i>284</i> | <i>70</i> | <i>-14</i> | <i>504</i> | <i>248</i> | <i>175</i> | <i>75</i> | <i>-266</i> | <i>439</i> | <i>127</i> | <i>121</i> | <i>36</i> | <i>329</i> | <i>375</i> | <i>443</i> | <i>439</i> | <i>-140</i> | <i>584</i> | | | | |
| <i>J tor</i> | <i>250</i> | <i>3</i> | <i>-95</i> | <i>302</i> | <i>25</i> | <i>319</i> | <i>343</i> | <i>54</i> | <i>-543</i> | <i>-1</i> | <i>-569</i> | <i>96</i> | <i>222</i> | <i>-371</i> | <i>-43</i> | <i>-513</i> | <i>-357</i> | <i>-744</i> | <i>-370</i> | <i>-407</i> | <i>491</i> | <i>264</i> | | | |
| <i>S ser</i> | <i>-22</i> | <i>-148</i> | <i>182</i> | <i>66</i> | <i>-20</i> | <i>30</i> | <i>140</i> | <i>-589</i> | <i>-233</i> | <i>146</i> | <i>-213</i> | <i>324</i> | <i>351</i> | <i>-26</i> | <i>-175</i> | <i>202</i> | <i>-187</i> | <i>463</i> | <i>-156</i> | <i>-111</i> | <i>-586</i> | <i>-24</i> | <i>71</i> | | |
| <i>M atb</i> | <i>-12</i> | <i>-29</i> | <i>40</i> | <i>386</i> | <i>169</i> | <i>-374</i> | <i>105</i> | <i>-127</i> | <i>-325</i> | <i>-153</i> | <i>-105</i> | <i>-94</i> | <i>-177</i> | <i>-211</i> | <i>-464</i> | <i>364</i> | <i>-649</i> | <i>-326</i> | <i>-680</i> | <i>218</i> | <i>-508</i> | <i>-432</i> | <i>-73</i> | <i>434</i> | |

LEGEND 800-1000 600-799 400-599 251-399 ≤ 251

Cluster 4: Chiffchaff, Blackcap, Sedge Warbler.

Cluster 5: Wood Warbler, Nightingale, Tree Pipit, Icterine Warbler.

Cluster 6: Lesser Whitethroat, Swift.

Singletons: Black Redstart; Cuckoo; Wryneck; White Wagtail; Serin.

A dendrogram representing the results of the average-linkage clustering (Fig. 2) shows essentially similar results, in fact identical at $r=0.55$. At a lower level of correlation ($0.4 < r < 0.5$), the relationships appear of Black Redstart to cluster 1, of Cuckoo to cluster 5, the clusters 3 and 4 join together, and White Wagtail phenologically relates to Serin. Chaffinch has been omitted from the average-linkage procedure because of a high proportion of its comparisons with a low number of pairs (5 or less) to other species. At an even lower level of relationships ($r=0.3$), five groups occur: 1) Cluster 1 + Black Redstart; 2) Clusters 2 + 3 + 4; 3) Cluster 5 + Cuckoo; 4) Cluster 6 + Wryneck; 5) White Wagtail + Serin. A further clustering seems little reasonable since the groups formed at $r < 0.3$ contain phenologically less related or unrelated species; within such groups, the proportion of significant links will be markedly below 50% out of the total number of the intra-group links.

By comparing the results of both cluster techniques, it seems that an optimum criterion for clustering could be at $r=0.5$ in the average-linkage method. At

this level of correlation, a proportion of significant ($P < 0.05$) links within each cluster is at least 50%, and this would suggest a high degree of compactness, i. e. little intra-group differences at sufficiently large inter-group variations. This rule ($r = 0.5$, average linkage) leads to construction of the following groups of phenologically related species of the birds, called "spring migrons":
 Migron A: Starling, Skylark, Black-headed Gull, Rook, Lapwing.

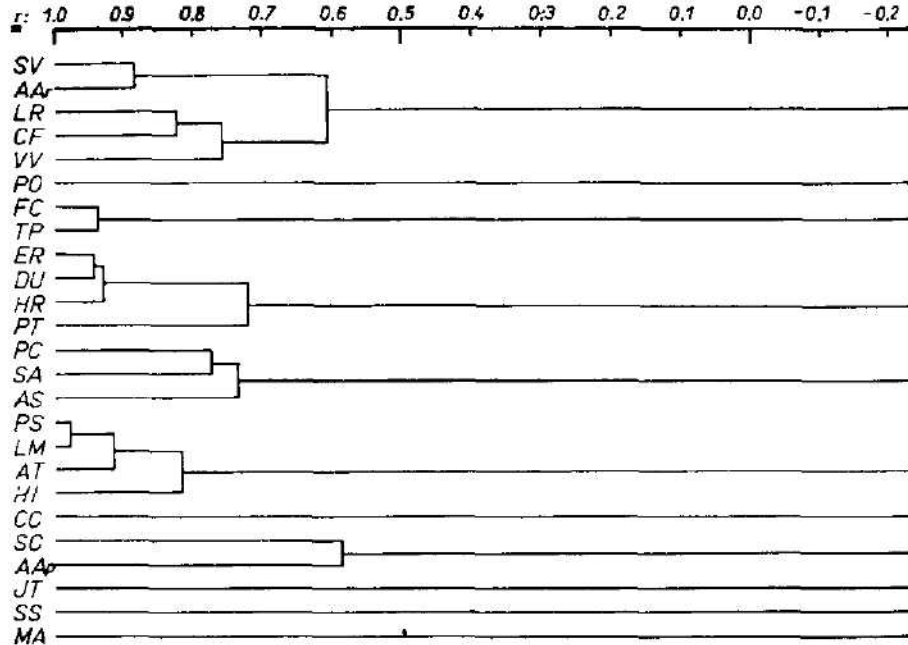


Fig. 1. Dendrogram of the half-linkage clustering of the species according to their spring migration pattern. The scientific names are abbreviated (the first letter for the capital letter of the generic name, the second one for the first letter of the specific name – cf. Results).

Migron B: Song Thrush, Chaffinch.

Migron C: Robin, Swallow, House Martin, Willow Warbler, Chiffchaff, Blackcap, Sedge Warbler.

Migron D: Wood Warbler, Nightingale, Tree Pipit, Icterine Warbler, Cuckoo.

Migron E: Lesser Whitethroat, Swift.

The other species (Black Redstart; White Wagtail; Serin; Wryneck) resulted as singletons. However, Black Redstart shows relationships to migron E, and White Wagtail is related to Serin in the phenological pattern.

DISCUSSION

The primary aim of this study has been to find correlations of phenological data between different species of birds, rather than their average data or a mean chronological sequence of the species in their spring arrival or migration

in Czechoslovakia. Interestingly, it appears that two or more species could be phenologically correlated though they do not coincide closely in their actual arrival date: Robin, House Martin and Swallow; Tree Pipit and Icterine Warbler; Chiffchaff and Blackcap. On the other hand, two species which, on a long-term average, coincide closely in their arrival date, need not be phenologically related: White Wagtail and Robin; Chiffchaff and Black Redstart; Sedge Warbler

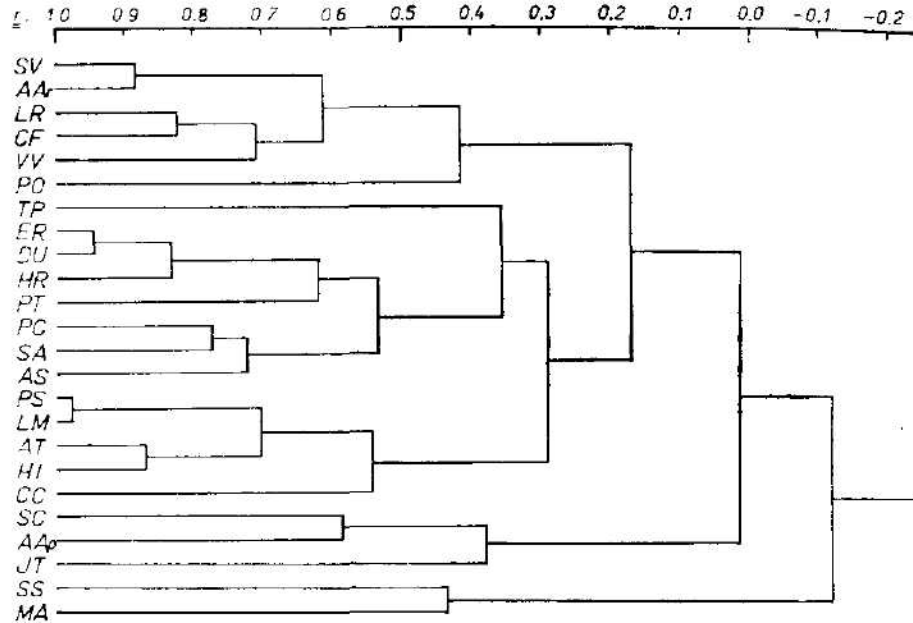


Fig. 2. Dendrogram of the average-linkage clustering of the species. (Chaffinch excluded.)

and Wryneck; Wryneck and House Martin; House Martin and Wood Warbler; etc. The correlation analysis yields thus another piece of information about the migration of birds than does the mean date of arrival. Generally, it seems that the birds of one spring migron share a similar winter quarter and/or breeding area whereas the birds from different migrons may differ in their winter and/or breeding ranges.

The comparison of two different clustering algorithms has shown that the results may vary a little. The half-linkage method produces compact clusters composed of mostly significantly inter-related members, and singletons as well. On the other hand, the average-linkage procedure results in a strictly hierarchical dendrogram that includes eventually all entities tested, irrespective of significance, and no singletons appear at the lowest level of correlation. On the basis of the average-linkage method we may therefore follow the hierarchical relationships among particular clusters. For the construction of migrons, the half-linkage algorithm seems preferable, because it has a clear-cut stopping rule based on significance of the values of correlation coefficient and brings,

moreover, less computational load than does the average-linkage clustering. However, when we wish to compare particular migrons and to reveal their hierarchy, then the average-linkage technique should be a method of choice.

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**NOTES ON THE PHENOMENON OF ROSA LEE ILLUSTRATED ON THE RUDD
GROWTH (SCARDINIUS ERYTHROPHthalmus, PISCES, CYPRINIDAE)**

Jindřich NOVÁK

Received April 28, 1981

Abstract. The Phenomenon of Rosa Lee was studied using length-growth tables of the Phenomenon of Rosa, Lee was made using tables of the growth of the rudd Klíčava valley reservoir in Central Bohemia (Czechoslovakia) in the years 1962—1979. Methods of studying, causes and consequences of this phenomenon are discussed. The selective mortality is probably responsible for the existence of the Lee's Phenomenon. The study of Lee's Phenomenon for each computed values computation and growth comparison.

MATERIAL AND METHODS

Most of the specimens of the rudd were caught using gill nets and seine nets. The growth was studied by means of measuring the scales. The numerical revaluation of the Phenomenon of Rosa Lee was made using tables of the growth of the rudd in 1962—1964 (Holčík, 1967), 1967—1972 (Peci, unpublished data), both computed by the method of Rosa Lee, and the author's own data 1975—1979. This material was calculated using again the Rosa Lee method and separate reading from the graph representing the body / scale relationship, which showed to be nonlinear in samples of the rudd in the Klíčava reservoir 1975—1979. The computed growth from one locality studied for several years allows the study of Lee's Phenomenon for each computed age and year separately.

RESULTS AND DISCUSSION

Methods of studying of Lee's Phenomenon

The Phenomenon of Rosa Lee was originally described as the diminishing of values of the computed growth in older age groups (Sund, 1911; after Ricker, 1969). It was also ascertained that the computed body lengths when using scales or otoliths of older specimens are lower than those computed for the same age from the younger ones. These presumptions did not admit the possibility that specimens of the same age could reach different body lengths in different calendary years. It is possible to explain this lowering of computed body lengths by the improvement of life conditions during subsequent years.

Kuznecov (1975) studied Lee's Phenomenon by comparing the measured body lengths in a certain year and calculated body lengths of the same specimens caught later. I have used a similar method here. Table 1 represents the calculated values of the growth of individuals born in the same year, but caught as different age classes in the following years. In each column of this table the calculated body lengths for the same age and calendary year are included. Available were tables of growth of specimens hatched in 1954, 1956, 1960, 1962, 1963, 1964, 1967, 1968, 1971, 1972, 1973, 1974 and 1976. The revaluation of the Phenomenon of Rosa Lee was made for each age group (I—VIII) separately. In each column of each table (of the same type as Table 1) relative differences were calculated,

always between two computed body lengths. The absolute difference in mm (obtained by the subtraction of the value computed from the specimens of the younger age group from the value computed from specimens of the older age group) was expressed in percent of the value computed from specimens of the younger age group. The existence of Lee's Phenomenon was also signed by the minus mark. For example Lee's Phenomenon for l_1 between age groups III and IV (Table 1) is $39 - 57 = -18$ mm, i. e. is -31.6% of 57. Thus the body length computed for the first years of life (l_1) from the specimens of age group III is larger by 18 mm (31.6%) in comparison with l_1 computed for the same calendary year from specimens of age group IV caught one year later. Here are the average computed body lengths of the rudd in the Klíčava reservoir 1962-1979 in mm: $l_1 = 41$, $l_2 = 99$, $l_3 = 152$, $l_4 = 172$, $l_5 = 184$, $l_6 = 191$, $l_7 = 207$, $l_8 = 212$, $l_9 = 212$, $l_{10} = 234$. The Phenomenon (the average diminishing of the computed body length) per one year in % is as follows: for $l_1 -3.9$, $l_2 -2.0$, $l_3 -2.4$, $l_4 -1.7$, $l_5 -1.3$, $l_6 -0.3$, $l_7 -5.1$, $l_8 -5.8$, which is, in mm (related to the average growth), for $l_1 -1.6$, $l_2 -2.0$, $l_3 -3.6$, $l_4 -2.9$, $l_5 -2.4$, $l_6 -0.6$, $l_7 -10.6$, $l_8 -12.3$. E. g., the body length computed for the second year of life (l_2) for the year t from the fourth age group caught in the year $t + 2$ is smaller by 2.0 percents, which is 2 millimetres in comparison with l_2 computed for the year t from the third age group caught in $t + 1$. The Phenomenon was ascertained in all age groups in average evaluation.

Causes of Lee's Phenomenon

In the literature the following main causes of this phenomenon are cited.

1. Biassed sampling. Smaller specimens usually are less numerous than larger ones in the sample of the same age group. Larger specimens can be caught more intensively due to their size and the selectivity of the gear used (Lee, 1912; Ricker, 1969).

2. Selective mortality. The mortality of the specimens of different size in the same age can be caused by the natural mortality, or by different possibilities of catching (fishing mortality) — Lee, 1912; Ricker, 1969.

The Phenomenon of Rosa Lee was proved for many fish species. Ricker (1969) showed this phenomenon in *Clupea sprattus*, *Perca flavescens* and *Ambloplites rupestris*. In some species, the manifestations of the Phenomenon changes with the age. Lea (1913) did not find the Phenomenon in older age groups of *Clupea harengus*, Tandon and Oliva (1957) in *Silurus glanis*, Shentya kova (1968) in *Abramis brama*. The same was described in relation to the industrial fishing. Carlander (1968) did not find the Phenomenon in the part of the population of *Stizostedion vitreum* younger than 3 years without the fishing pressure. Biljko (1971) found a stronger manifestation of the Phenomenon in populations of *Gobius fluviatilis*, *Gobius batrachocephalus*, *Gobius syrman* and *Gobius melanostomus* caught by the fish industry in comparison to those not influenced by fishing. According to Kuznecov (1957), in *Carassius auratus gibelio* and *Thymallus arcticus baicalensis*, the Phenomenon appears as a results of the lower survival rate of specimens, which grew rapidly in the first year of life. But most of the above mentioned conclusions were made using normal growth tables only, regardless to the possibility of growth changes in the subsequent years. Holčík (1969) found the Phenomenon in age group I of *Rutilus rutilus* and *Perca fluviatilis*, when he used the actually measured body lengths during the spring-autumn period.

The use of an incorrect scale (sensu Ricker, 1969) may have some observable influence on the values of the Phenomenon computed but it cannot probably be the chief cause with regard to the existence of many references to the Phenomenon cited above.

The use of the method of Rosa Lee may have some influence on the ascertaining of the Phenomenon when the body/scale relationship showed in Fig. 1 is

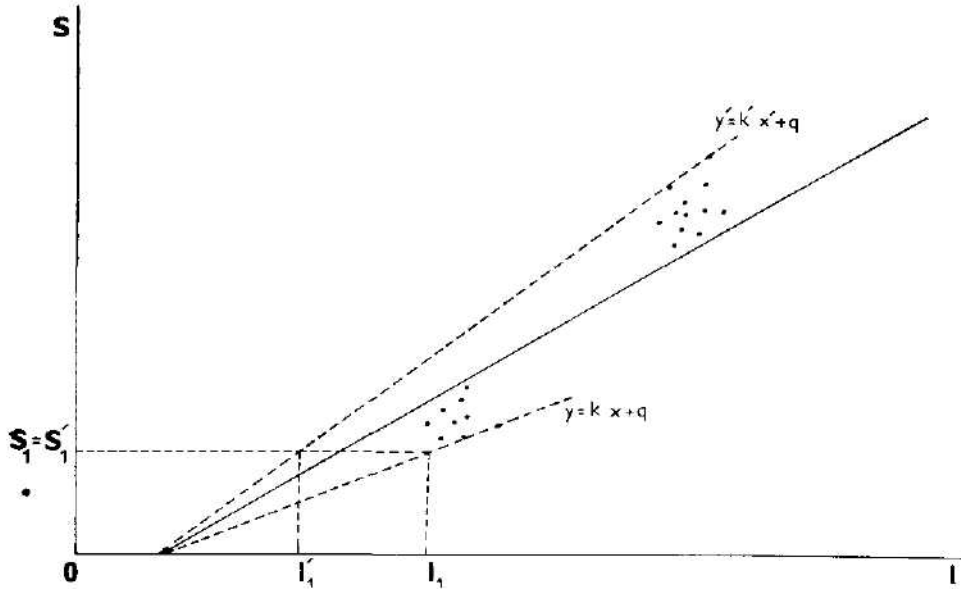


Fig. 1. Demonstration of the influence of the back calculation of the growth upon the ascertaining of the Phenomenon of Rosa Lee, when Lee's method is used for a nonlinear body/scale relationship. S... diameter of scale, l... body length. By the computation of straight lines for each specimen (Lee's method) we obtain larger values of l for diameter of the scale S_1 (= distance of the 1st anulus from the centre of the scale) for smaller specimens than for larger specimens with the same distance of the 1st anulus from the centre of the scale. $S_1 = S'_1$, $l_1 > l'_1$.

found. It is evident from Fig. 1 that the use of the linear method for the nonlinear body/scale relationship gives lower back calculated growth values in larger specimens (which are usually older) in comparison with younger (and smaller) ones. Biljko (1971) found the Phenomenon in four species of gobiids (see above) using otoliths measurements. Holčík (1960) found the Phenomenon in *Rhodeus sericeus amarus* using several methods of the growth values computation. I compared the values of the Phenomenon of Rosa Lee computed from body/scale graph (values of the Phenomenon: for $l_1 -1.7\%$, $l_2 -0.5\%$, $l_3 -2.9\%$, $l_2 -3.7\%$, $l_3 -2.2\%$, $l_4 -1.3\%$, $l_5 +0.2\%$, $l_6 +6.4\%$) and by reading from the body/scale graph (values of the Phenomenon: for $l_1 -1.7\%$, $l_2 0.5\%$, $l_3 -2.9\%$, $l_4 -1.2\%$, $l_5 -0.4\%$, $l_6 +3.4\%$); both for tables of the growth of the rudd in the Klíčava reservoir in 1975—1979. No remarkable differences were found here. The ascertainment of the Phenomenon cannot be probably markedly influenced by the method of the growth values back calculation.

Table 1. The growth of specimens of the rudd hatched in the year 1972
(all lengths in mm)

| Year of catching | Age group | Average body length | n | Back calculated body lengths | | | | | | | |
|------------------|-----------|---------------------|----|------------------------------|----------------|----------------|----------------|----------------|----------------|----------------|--|
| | | | | l ₁ | l ₂ | l ₃ | l ₄ | l ₅ | l ₆ | l ₇ | |
| 1975 | III | 174 | 5 | 57 | 112 | 153 | | | | | |
| 1976 | IV | 186 | 3 | 39 | 96 | 135 | 186 | | | | |
| 1977 | V | 199 | 3 | 41 | 91 | 131 | 170 | 190 | | | |
| 1978 | VI | 201 | 21 | 41 | 102 | 137 | 157 | 180 | 193 | | |
| 1979 | VII | 211 | 5 | 39 | 103 | 143 | 164 | 187 | 203 | 219 | |

The rudd population in the Kličava reservoir is not influenced by fishing. The negative influence of its own abundance upon its growth rate was not found in most numerous age groups (10—100 individuals per one ha). The vegetarian mode of feeding probably persists from the end of the first year of life. The natural selective mortality is therefore probably main cause of the existence of Lee's Phenomenon in the rudd population in the Kličava reservoir.

Consequences of Lee's Phenomenon for the evaluation of fish growth

Table 2 shows the model of the growth of the rudd in the Kličava reservoir. The average growth values (last values for each age group in the growth table) decrease by the average values of the Phenomenon of Rosa Lee computed above in each column of each table of the model. The model does not admit the possibility of changes of the growth in the subsequent years. From the model it is evident that:

1. The grand average depends on age composition of the sample due to the existence of the Phenomenon of Rosa Lee. Each sample is influenced by the actual age composition of the studied population and by the selectivity of the gear.

2. The grand average is computed from the body lengths which are reached by the specimens studied in the subsequent years. The table of the growth in various growth studies is usually designated by the year of catching of the specimens examined. Only the actually measured body lengths in the time of annulus formation, or the last values in each line of the table (i. e. the last computed values for each age group only) can be used as the growth values for the year of the catching. For the growth and production computations see Ricker (1969).

3. The grand average depends on the type of average used (simple or weighed arithmetic average).

The comparison of the absolute length increment obtained from grand averages and from the value computed from the final pair of values in each line of the tables of the Model (computed after Ricker, 1969) showed relative differences of 3.3—26.7%. When using the absolute weight increment ($\log w = 3.1082702$, $\log l = 4.8231081$ for $w_2 - w_6$; $\log w = 2.8842290$, $\log l = 4.4401284$ for w_1) the relative differences are 7.1—22.5%. In the available production differences computed by the same way are 4.1—10.2%. Due to large differences computed the values from grand averages should not be used in growth comparison and growth values computation.

Table 2. The model of the growth of the rudd

Model no. 1

| Age group | n | l ₁ | l ₂ | l ₃ | l ₄ | l ₅ | l ₆ |
|-------------------------------------|---|----------------|----------------|----------------|----------------|----------------|----------------|
| I | 1 | 41 | | | | | |
| II | 1 | 39 | 99 | | | | |
| III | 1 | 37 | 97 | 152 | | | |
| IV | 1 | 36 | 95 | 148 | 172 | | |
| V | 1 | 35 | 93 | 144 | 169 | 184 | |
| VI | 1 | 34 | 91 | 140 | 166 | 182 | 191 |
| Simple average = Weighed average | 6 | 37 | 95 | 146 | 169 | 183 | 191 |

Model no. 2

| Age group | n | l ₁ | l ₂ | l ₃ | l ₄ | l ₅ | l ₆ |
|-----------------|----|----------------|----------------|----------------|----------------|----------------|----------------|
| I | 1 | 41 | | | | | |
| II | 2 | 39 | 99 | | | | |
| III | 4 | 37 | 97 | 152 | | | |
| IV | 9 | 36 | 95 | 148 | 172 | | |
| V | 16 | 35 | 93 | 144 | 169 | 184 | |
| VI | 32 | 34 | 91 | 140 | 166 | 182 | 191 |
| Simple average | 63 | 37 | 95 | 146 | 169 | 183 | 191 |
| Weighed average | | 35 | 93 | 143 | 164 | 183 | 191 |

Model no. 3

| Age group | n | l ₁ | l ₂ | l ₃ | l ₄ | l ₅ | l ₆ |
|-----------------|----|----------------|----------------|----------------|----------------|----------------|----------------|
| I | 32 | 41 | | | | | |
| II | 16 | 39 | 99 | | | | |
| III | 8 | 37 | 97 | 152 | | | |
| IV | 4 | 36 | 95 | 148 | 172 | | |
| V | 2 | 35 | 93 | 144 | 169 | 184 | |
| VI | 1 | 34 | 91 | 140 | 166 | 182 | 191 |
| Simple average | 63 | 37 | 95 | 146 | 169 | 183 | 191 |
| Weighed average | | 39 | 97 | 149 | 170 | 183 | 191 |

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SUMMARY

Causes and consequences of the well-known existence of the Phenomenon of Rosa Lee were studied using tables of the growth of the rudd from the Kličava reservoir. Calculations of the Phenomenon were made for each year of life, age group and calendary year separately. The Phenomenon exists in all age groups (I—VIII) studied. Methods of the back calculation of body lengths have not remarkable influence on the existence of this phenomenon. In my case, the Phenomenon is probably caused by the higher natural mortality of the more rapidly growing specimens. As it was proved in the selected model, computations of relative indexes of the growth should be based on the values computed only for each age group (each line of the growth table) separately.

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**EVALUATION OF THE GROWTH STRATEGY OF THE RUDD (SCARDINIUS
ERYTHROPHthalmus; PISCES: CYPRINIDAE)**

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Abstract. The growth of the rudd in selected types of water bodies was compared. The slowest growth tempo was ascertained in central European backwaters, the fastest in rivers and lakes of the south part of the USSR. Some factors affecting the possibilities of comparison of the fish growth in different localities or regions are discussed.

MATERIAL AND METHODS

Different localities from which the growth data were at disposal were joined into several groups (Table 1) where the further details are referred to. Averages of the growth (Tables 2—5) were computed from the growth tables of different localities (see also Literature). Including the data of Gal'cova (1954), Penjaz and Schevtsova (1963), Pichu (1968), Solovkina (1969) — all authors cited according to Trjapicyna (1975); and Papadopol (1970) which all are discussed in the text, more than 4507 specimens of the rudd were investigated (Table 1). Out of these as many as 3340 specimens originated from four localities (or groups of localities): the Volga delta (Trjapicyna, 1975), the Klíčava reservoir (Holčík, 1967; Novák, 1980; Novák and Frank, 1981), the inundation region of the river Labe (Novák, 1982) and lakes of the Węgorzewo district in Poland (Zawisza and Żuromska, 1961). When it was possible, two types of averages were computed for each group of localities (Table 1): 1. averages from grand averages of each locality and 2. averages from last growth values of each age group (last values in lines of growth tables) of each locality (Table 2—5). The author's own scale material was studied after Novák and Frank (1981). The significance of growth differences among different groups of localities (Table 1) was studied using the construction of 95% confidence intervals: $\bar{x} \pm s_{\bar{x}} \cdot t$, where \bar{x} ... average body length for the certain group of localities and certain age, $s_{\bar{x}}$... standard error of the mean, t ... critical value ($\alpha = 0.05$). If confidence intervals were overlapping, differences were considered to be significant.

RESULTS AND DISCUSSION

Results are summarized in Tables 2—5. Differences among selected groups of localities are mostly insignificant, but distinct. The average growth of the rudd living under the low temperature (Scandinavian, Alpine and north-European lakes) — Table 2 is slower than in regions with the higher average year temperature (lakes and rivers of the south part of the USSR). The growth of the rudd in central European lakes is similar to the growth in cold waters of the northern Europe. In cold waters the maximum age of the rudd is very high (Table 2), much higher than in other groups of localities. The slowest growth was found in the natural ponds (backwaters) in the inundation regions of large central European rivers (Labe, Dyje) — Table 4. The relative fast growth tempo was found in artificially created water bodies (fishponds and river reservoirs). The

Table 1. Review of examined material of the rudd

| Groups of localities | Number of localities being at disposal | Total number of specimens | Author |
|--|---|---|--|
| Scandinavian lakes | 10 | more than 113* | Jääskeläinen, 1917, 1931; Alm, 1922; Järnefelt 1925 — all cited following Zawisza and Żuromska, 1961; Järnefelt, 1921; Otterström, 1930—1931, 1940 |
| Lakes and rivers of England, north part of Germany and Poland | 34 and average from 28 lakes in North Germany | more than 545* | Bauch, 1953; Geyer, 1938; Frank, 1962; Hartley, 1947; Zawisza and Żuromska, 1961 |
| Lakes in Alps | 3 | more than 70*) | Bauch, 1953; Kolder, 1970 |
| Rivers of Central Europe | 11 | 44 | Čihař and Frank, 1958; Novák, 1982, unpublished data |
| River reservoirs of Central Europe | 5 | 1093(966 from the Kileava reservoir) | Frank, 1959; Novák, 1980; Novák and Frank 1981; own unpublished data |
| Inundation areas of Central Europe | 13 | 800(709 from backwaters of the river Labe) | Čihař and Frank, 1958; Frank, 1962; 1969; Oliva 1957; Novák, 1982 |
| Lakes of Central Europe | 9 | more than 289* | Haack, 1929 (cited following Bauch, 1953); Stroński, 1971; Żuromska, 1977 |
| Fishponds in Central Europe | 15 | 96 | Čihař and Frank, 1958; own unpublished data |
| Rivers in south of European part of USSR (including inundation areas and deltas) | 4 | more than 1234* (1134 from the Volga delta) | Egerman, 1926; Karpenko, 1966; Tereshchenko, 1913; all cited following Trjapicyna 1975; Berg, 1949; Trjapicyna, 1975 |
| Lakes and rivers of Asian part of USSR | 4 (including the average growth of lakes in western Kazakhstan) | more than 38 | Drjagin, 1936; Sorov, 1959; all cited following Trjapicyna, 1975; Berg, 1949 |

*) some authors do not give number of specimens investigated

Table 2. The average growth of the rudd in selected localities

| Average body length | Scandinavian lakes (probably only grand averages) | Lakes and rivers of England, north part of Germany and Poland (probably only grand averages) | Lakes and rivers of north part of Germany Poland (probably only grand averages) | Lakes in Alps (probably only grand averages) |
|---------------------|---|--|---|--|
| l ₁ | 30 ± 10.55 (17—50) | 42 ± 3.90 (34—75) | 39 ± 1.22 (36—44) | 38 ± 21.67 (32—48) |
| l ₂ | 62 ± 18.64 (30—100) | 68 ± 3.48 (50—93) | 66 ± 2.76 (59—84) | 72 ± 39.94 (60—90) |
| l ₃ | 95 ± 25.87 (47—144) | 97 ± 6.06 (81—138) | 95 ± 5.57 (76—135) | 104 ± 54.14 (89—129) |
| l ₄ | 124 ± 26.61 (64—172) | 119 ± 7.57 (92—160) | 118 ± 8.19 (92—160) | 128 ± 63.39 (109—157) |
| l ₅ | 153 ± 26.40 (85—206) | 137 ± 8.35 (106—181) | 136 ± 8.69 (118—181) | 149 ± 79.86 (127—186) |
| l ₆ | 170 ± 38.75 (105—234) | 159 ± 8.79 (122—186) | 159 ± 8.92 (126—185) | 167 ± 91.83 (145—210) |
| l ₇ | 185 ± 34.35 (124—254) | 185 ± 11.03 (134—218) | 184 ± 12.23 (143—218) | 180 ± 101.13 (156—227) |
| l ₈ | 208 ± 38.32 (145—286) | 207 ± 8.68 (184—232) | 206 ± 9.09 (184—232) | 207 ± 165.52 (168—245) |
| l ₉ | 218 ± 42.97 (157—306) | 233 ± 13.86 (193—294) | 227 ± 13.46 (193—260) | 261 |
| l ₁₀ | 216 ± 41.19 (167—265) | 240 ± 32.75 (185—301) | 230 ± 25.47 (185—259) | 273 |
| l ₁₁ | 245 ± 28.81 (225—265) | 265 ± 33.30 (227—320) | 254 ± 21.39 (227—275) | 283 |
| l ₁₂ | 243 ± 43.67 (202—280) | 270 ± 76.67 (235—292) | 270 ± 140.80 (235—292) | 291 |
| l ₁₃ | 258 ± 28.48 (233—286) | 271 ± 152.74 (235—306) | 271 ± 152.74 (235—306) | 305 |
| l ₁₄ | 279 ± 120.90 (266—311) | 287 ± 75.15 (269—304) | 287 ± 75.15 (269—304) | 311 |
| l ₁₅ | 290 | 300 ± 60.50 (286—313) | 300 ± 60.50 (286—313) | — |
| l ₁₆ | 311 | 318 | 318 | — |
| l ₁₇ | 302 | — | — | — |
| l ₁₈ | 294 | — | — | — |

growth of the rudd in the river reservoirs of central Europe is better than in the rivers of the same region. (Table 3).

Now to localities not included in Tables 1—5. The rudd from the North Dvina basin (USSR) grows as follows: l₁ = 35, l₂ = 67, l₃ = 91, l₄ = 108, l₅ = 122, l₆ = 129—131, l₇ = 161, l₈ = 174, l₉ = 190 mm, following Solovkina (1969); its growth is slower than in the Scandinavian lakes (Table 2). In the lakes of the Baltic Sea region of the USSR (Pichu, 1968) the growth of the rudd is the following: l₁ = 30—45, l₂ = —, l₃ = 95—115, l₄ = —, l₅ = 140—160, l₆ = —, l₇ = —, l₈ = 190—220 mm, a little better than in the lakes of northern Poland and Germany situated more to the south (Table 2). In the lake Tschervonoe (White Russia, USSR) the growth of the rudd (Gal'cova, 1954) is considerably better (l₁ = 50.5, l₂ = 93, l₃ = 128.5, l₄ = 158.5, l₅ = 180, l₆ = 205, l₇ = 219, l₈ = 231 mm) than in the mentioned lakes of the Baltic Sea region, even if they

Table 3. The average growth of the rudd in selected localities

| Average body length | Rivers of Central Europe (grand averages) | Rivers of Central Europe (last values of lines in growth tables) | River reservoirs of Central Europe (grand averages) | River reservoirs of Central Europe (last values of lines in growth tables) |
|---------------------|---|--|---|--|
| l_1 | 35 ± 2.52 (30—41) | 39 ± 12.86 (32—46) | 35 ± 9.54 (26—47) | 41 |
| l_2 | 74 ± 12.14 (58—108) | 83 ± 39.31 (70—108) | 76 ± 23.11 (56—101) | 101 ± 8.52 (99—103) |
| l_3 | 103 ± 16.27 (81—135) | 109 ± 44.09 (94—137) | 115 ± 24.26 (96—140) | 131 ± 55.65 (96—152) |
| l_4 | 132 ± 23.88 (105—164) | 157 ± 57.87 (126—189) | 146 ± 15.18 (133—160) | 159 ± 29.95 (141—172) |
| l_5 | 151 ± 21.95 (137—160) | 161 ± 2.13 (160—161) | 166 ± 10.23 (155—177) | 169 ± 15.06 (155—184) |
| l_6 | 173 ± 14.70 (165—181) | 172 ± 10.65 (169—174) | 178 ± 15.40 (163—187) | 180 ± 17.35 (163—191) |
| l_7 | 196 ± 42.90 (186—206) | — | 203 ± 8.52 (201—205) | 205 ± 8.52 (203—207) |
| l_8 | 209 ± 38.64 (200—219) | 218 | 210 | 212 |
| l_9 | 210 | — | 221 | 212 |
| l_{10} | 223 | — | 236 | 234 |
| l_{11} | 240 | — | — | — |
| l_{12} | 254 | 254 | — | — |

are situated a little more to the south. In the river Drissa (White Russia, USSR) the growth ($l_1 = 32$, $l_2 = 64$, $l_3 = 94$, $l_4 = 123$, $l_5 = 150$, $l_6 = 171$, $l_7 = 185$, $l_8 = 195$, $l_9 = 205$ mm) of the rudd is similar to the growth in the lakes in the northern part of Germany and Poland (Table 2). The average growth of the rudd from the Rumanian locality Rosulet (Danube river delta) shown by Papadopol (1970): ($l_1 = 60$, $l_2 = 112$, $l_3 = 150$, $l_4 = 193$, $l_5 = 226$, $l_6 = 251$ mm) is very rapid, even in comparison with some data of the growth in the southern part of the USSR (Table 5).

Among selected groups of localities some considerable differences were found which are significant only in a few cases (Tables 2—5). Comparability of these average growth values is influenced by the following factors:

1. The specificity of different localities (water bodies) and non available distribution of these localities into several groups (Table 1). This distribution was made with regard to the macroclimatic temperature conditions. Simultaneously some localities with special conditions were selected (Alpine lakes; artificially created water bodies: used by fish industry — fishponds, primarily not used for fish keeping and breeding — river reservoirs; with the great amount of submerged water plants and periodically overflowed backwaters in inundation areas of large rivers). I suppose that the water temperature is the main factor affecting the growth of many fish species (see Love, 1976; Wilkońska and Żuromska, 1977; Żuromska, 1977), naturally together with the food supply. But in the same climatic region there are many different additional factors and relationships which can affect the growth of fishes. These relationships are not sufficiently investigated, for example the abundance / growth relationship of natural fish populations, but they are probably able to "mask"

Table 4. The average growth of the rudd in selected localities

| Average body length | Inundation areas of Central Europe (grand averages) | Inundation areas of Central Europe (last values of lines in growth tables) | Lakes of Central Europe (grand averages) | Lakes of Central Europe (last values of lines in growth tables) |
|---------------------|---|--|--|---|
| l ₁ | 35 ± 2.59 (30—43) | 36 ± 3.34 (29—41) | 41 ± 5.54 (34—53) | 47 |
| l ₂ | 62 ± 5.91 (47—78) | 64 ± 6.41 (48—76) | 71 ± 6.61 (63—82) | 64 ± 5.13 (0—69) |
| l ₃ | 84 ± 8.53 (63—107) | 85 ± 9.50 (70—107) | 107 ± 18.77 (91—114) | 89 ± 2.76 (88—91) |
| l ₄ | 98 ± 9.95 (79—124) | 97 ± 9.34 (79—121) | 133 ± 20.38 (110—175) | 122 ± 37.33 (104—162) |
| l ₅ | 125 ± 21.93 (113—148) | 121 ± 25.82 (105—147) | 156 ± 18.59 (126—190) | 135 ± 40.36 (104—191) |
| l ₆ | 156 ± 32.15 (138—173) | 124 ± 51.73 (112—136) | 179 ± 14.72 (172—202) | 178 ± 15.52 (172—202) |
| l ₇ | — | — | 196 ± 7.34 (192—200) | 192 ± 9.19 (187—197) |
| l ₈ | — | — | 224 ± 14.91 (220—227) | 224 ± 14.91 (220—227) |
| l ₉ | — | — | — | — |
| l ₁₀ | — | — | — | — |
| l ₁₁ | — | — | 265 | 265 |

the influence of temperature conditions, which was illustrated by H a n e l (1980) in the chub (*Leuciscus cephalus*) in the Klíčava reservoir. Considering the growth of the rudd the influence of the average temperature during the March — October season upon the absolute length increment in the Klíčava reservoir (Central Bohemia) was not ascertained. But the influence of the abundance of the rudd population upon the growth rate was not ascertained in this species in the mentioned reservoir either, probably due to the great amount of water plants which represent a sufficient food supply for the rudd (N o v á k, 1980). In backwaters in the inundation region of the river Labe in central Bohemia (where the great amount of submerged water plants is also observed), the growth of the rudd is considerably slower and the Fulton's coefficient value lower than in the Klíčava reservoir. But the abundance in these backwaters (in average 4352, ranging from 80 to 17.000 specimens per one ha) was not found to be a factor affecting the growth of this species (N o v á k, 1982). These must be some other, still unknown factors which are responsible for the slowest growth of the rudd in the backwaters in comparison with the other types of water bodies (F r a n k, 1962).

2. The individual variability. The individual growth variability is not included in Tables 2—5. Ranges in these tables respect only the locality as a smallest unit, not the specimen. Therefore ranges in Tables 2—5 are average growth values from the locality with the slowest (min.) and the fastest (max.) growth. Ranges which respect the variability of different specimens are broader; confidence intervals should be naturally influenced by this factor.

3. The number of specimens and localities investigated. The computation of the average growth in each group of localities was made regardless of the number

Table 5. The growth of the rudd in selected localities

| Average body length | Fishponds in Central Europe (grand averages) | Fishponds in Central Europe (last values of lines in growth tables) | Rivers in south of European part of USSR (probably only grand averages) | Lakes and rivers of Asian part of USSR (probably only grand averages) |
|---------------------|--|---|---|---|
| l ₁ | 45 ± 7.81 (29—77) | 47 ± 28.74 (39—66) | 44 ± 9.19 (39—49) | 53 ± 25.72 (37—63) |
| l ₂ | 88 ± 14.16 (58—134) | 89 ± 35.22 (48—156) | 89 ± 19.99 (68—99) | 90 ± 32.20 (62—115) |
| l ₃ | 119 ± 18.39 (92—183) | 131 ± 28.16 (92—197) | 134 ± 38.45 (95—158) | 127 ± 41.64 (96—163) |
| l ₄ | 139 ± 16.38 (115—197) | 154 ± 21.60 (149—159) | 169 ± 51.36 (127—217) | 161 ± 41.60 (126—195) |
| l ₅ | 162 ± 27.07 (129—213) | 167 ± 120.49 (139—195) | 207 ± 88.18 (172—262) | 193 ± 64.30 (155—224) |
| l ₆ | 198 ± 28.58 (150—235) | 222 ± 55.99 (209—235) | 227 ± 56.22 (205—262) | 211 ± 81.85 (192—230) |
| l ₇ | 204 ± 34.56 (178—236) | 236 | 308 | 209 |
| l ₈ | 211 ± 31.05 (199—230) | 217 ± 58.12 (203—230) | 323 | — |
| l ₉ | 226 | — | 333 | 250 |
| l ₁₀ | 234 | 234 | — | — |

of specimens being available from different localities. The validity of the average growth data is in Tables 2—5 diminished by the fact that the growth data of some localities are represented only by one or a few specimens. Until now there exist only few localities in which the growth was computed from more than 500 specimens of the rudd (1,134 specimens from the Volga delta, 966 specimens from the Klíčava reservoir, 709 specimens from the river Labe inundation region and 531 specimens from lakes of the Wegorzewo district) — see Table 1.

4. The method of back calculation of the growth. Some authors did not cite the method of back calculation of the growth. The method of Rosa Lee apparently often used in the scale studies. It is not possible, however, to use this method only for the so-called “comparability” of growth values obtained by this method or the so-called “simplicity” of this method (for further details see Carlander, 1956; Holčík, 1960, 1962). Novák (1982) found a number of, in many cases, significant differences between the method of R. Lee and the direct reading from the body/scale graph (after the method of Segerstråle, 1933) when they had been used for a nonlinear body/scale relationship found in the rudd in the Klíčava reservoir.

5. The type of the average used and the Phenomenon of Rosa Lee. Due to the Phenomenon of Rosa Lee the values of grand averages are different from last values in each line of the growth table (Ricker, 1969; Novák, 1981, 1983). The grand average is additionally influenced by the different growth in one locality in subsequent years and, due to the Phenomenon of Rosa Lee, by the age composition of the investigated sample. Therefore there are considerable differences between the average growth values of one group of localities computed from grand averaged of different localities and those computed from

last values for each age group (each line of the growth table). Probably mainly due to the existence of the Phenomenon of Rosa Lee the values computed from grand averages are mostly lower than those computed from last values for each age group (Tables 2—5). It is evident from Tables 4 and 5 that absolute differences between the data computed by the two mentioned methods for the lakes of central Europe are approximately as considerable as differences between the grand averages from the fishponds of central Europe and the lakes of the same region.

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SUMMARY

An attempt for the comprehensive evaluation of the growth of the rudd in the ranges of its distribution area was made using original and literary data. It was found that:

1. The number of specimens of the rudd and the number of localities presently investigated is too low to make definite conclusions for the growth differences in different selected localities within geographical areas.

2. The question of the use of different methods for the back calculation of the growth is generally not satisfactorily solved. The author proposes the use of the actual empirical body / scale graphs for each locality or year.

3. Generally, the uniform concept of the growth data comparison is lacking. Grand averages, which are broadly used, are not satisfactory.

4. Effects of essential abiotic and biotic factors which can affect the growth of fishes are not fully known yet.

5. Therefore it is not possible to generalize satisfactorily the data of the growth of the rudd published within the last 70 years.

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*) not seen in original

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**ZUR PUPPENMORPHOLOGIE UND —TAXONOMIE DER DENDROPHILEN
ARTEN AUS DER TRIBUS EUCOSMINI (LEPIDOPTERA, TORTRICIDAE)**

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Abstract. The pupae of 48 dendrophilous species of tribus Eucosmini (Lepidoptera, Tortricidae) from Central Europe are described and a key for determining them is given. 42 species originate from Slovakia, 1 species from Denmark, the rest is based on the literature data only. The present system of this group is discussed from the point of view of pupal characters.

In diesem Beitrag, welcher an die von Patočka (1980, 1982) veröffentlichten Arbeiten anknüpft, werden die Puppen von dendrophilen Arten einer weiteren Tribus der Tortricidae, der Eucosmini Obratzov, 1946 behandelt. In der dem Verfasser zugänglichen Literatur sind die Puppen dieser Gruppe bisher nicht komplex bearbeitet worden. Mehrere Arbeiten, z. B. Evenhuis et al. (1973), Patočka et al. (1960), Patočka (1980 a), Schröder (1968) und Speyer (1958) betreffen jedoch einige vom Gesichtspunkte der Land- und Forstwirtschaft interessante Arten. Bei vielen anderen stehen nur kurzbindige und zur Bestimmung nicht ausreichende oder überhaupt keine Beschreibungen in den Handbüchern z. B. in Bradley et al. (1979) zur Verfügung. Die Bestimmung der Vertreter dieser Gruppe bereits im Puppenstadium ist aber für das Verfolgen vieler theoretischen und praktischen Fragen sehr nötig, weil dieselbe besonders wichtige forst- und landwirtschaftliche Schädlinge umfasst.

In dieser Arbeit werden 48 Arten von 12 Gattungen behandelt. Die Stellung der einzelnen Taxone im modernen System der Tortricidae nach Obratzov (1954—1961), Hannemann (1961) und Bradley et al. (1979) wurde auf Grund der Puppentaxonomie diskutiert.

MATERIAL UND METHODIK

Durch lange Jahre wurden Puppen und Puppenexuvien gesammelt und trocken aufbewahrt, sodass die Mehrzahl der behandelten Arten von der Sammlung des Verfassers aus der Slowakei stammt. Die Puppe von *R. naevana* hat mir freundlicherweise Dr. O. Karsholt (Praestø, Dänemark) zur Verfügung gestellt, wofür ich ihm zum Dank verbunden bin. *B. posticana*, *R. duplana*, *R. pinicolana*, *R. pinivorana* und *C. sylvestrana* wurden nach Angaben der zitierten Literatur bearbeitet. Die meisten der erwähnten Arten lagen in grösseren Serien vor. Die Beschreibung und Zeichnung erfolgte mit Hilfe eines Stereomikroskopes, teilweise auch des Abbe'schen Zeichenapparates. Als Unterlage benützte ich Verbandzeugwatte, an welcher das Objekt die gewünschte Lage behält.

DIE WICHTIGSTEN MERKMALE UND IHRE VARIABILITÄT

Ausser der Länge und Breite, Färbung der Puppe und ihrer Exuvie bzw. der Skulptur und des Glanzes werden folgende Merkmale berücksichtigt: Form der Stirn und der Oberlippe, rel. Länge der Fühler, der Zunge und Unterlippe, Bau

des Vorder- und Hinterbrustrückens, Form des Spitzenteiles der Vorderflügel, Anwesenheit, Grösse, Dichte und Form der Dornen am Rücken der Hinterleibsringe. An- oder Abwesenheit, bzw. Form des Kremasters, bzw. der Kaudalplatte (am Ende des 10. Hinterleibsringes von dessen Dornen dorsal und lateral umgrenzt). Zahl, Form und Grösse der Borsten an den Hinterleibsringen, insbes. der Gruppe VII (laut Gerasimov, 1950), die denen bei den Raupen entsprechen. Zahl, Form und Grösse der Häkchen am 10. Hinterleibsring.

Die Puppen variieren rel. stark, insbes. nach den Geschlechtern. Auch die erwähnten Hauptmerkmale variieren ziemlich. Trotzdem war es möglich verlässliche Merkmale zum Charakterisieren der Gattungen und meisten Arten festzustellen.

ABKÜRZUNGEN

Bre = Baselreihe, Bt = Borste, Borsten, D = Dorn, Dornen, Eh = Endhäkchen, F = Fühler, Hbr = Hinterbrustrücken, Hlb 1–10 = 1.–10. Hinterleibsring (-glied), Kpe = Kaudalplatte, Kr = Kremaster, Kre = Kaudalreihe, Kaudalreihen, P = Puppe, Puppen, Peh = Perianalhäkchen, Rbt = Rückenborsten, Vbr = Vorderbrustrücken, Vfl = Vorderflügel.

CHARAKTERISTIK DER PUPPEN DER TRIBUS EUCOSMINI

Stirn zwischen den F ± hervorstehend, manchmal auch mit einem Fortsatz nach vorn oder schräg nach oben gerichtet. Hbr meist zu $\frac{1}{3}$ – $\frac{2}{3}$ ausgeschnitten, zuweilen mit Leistengebilden. D am Hlb 4–6 insbes. die der Kre meist rel. steil, seltener wenig steil und kammartig (nach vorne leistenartig fortgesetzt, dazwischen feine Rinnen). Selten sind die D der Bre mehrfach. Kr reduziert oder fehlend, die Kpe aber meist ± gewölbt, Hlb 10 meist länger als seine Eh. Die Zahl der Eh sowie der Peh variiert zwischen 1–4 Paaren, selten fehlen die Peh überhaupt.

Die Vertreter der Tribus Archipini, Tortricini und Olethreutini unterscheiden sich meistens durch den entwickelten Kr, oft auch durch den Mangel der D am Hlb 10. Bei der Tribus Onephasiini sind die D am Hlb 10 meist stark vergrössert. Die Tribus Grapholitini unterscheiden sich gewöhnlich durch die abgerundete, zwischen den F nicht hervortretende Stirn, durch den kurzen Hlb 10, oft auch die kammförmige Kre, bzw. mehrfache Bre der D am Hlb 4–6.

Die Raupen der dendrophilen Eucosmini leben zwischen den versponnenen Blättern (Nadeln) bzw. Trieben, seltener in den Blüten, Früchten, in Innern der Knospen oder Trieben, bzw. in den Gallen. Manche Arten minieren die Blätter, wenigstens jung. Selten verzehren die jungen Raupen abgestorbene Pflanzenteile. Die Verpuppung findet meist am-oder im Boden in einem Erdkoton, nicht selten auch am Frassort im Gehäuse der Raupe statt.

BESTIMMUNGSTABELLE DER GATTUNGEN DER DENDROPHILEN VERTRETER DER TRIBUS EUCOSMINI

(Von den mitteleuropäischen fehlen noch *Gibberifera* Obraztsov, 1946 und *Gravitarmata* Obraztsov, 1946 mit je einer Art.)

- | | | |
|----|--|---|
| 1. | Vbr mit einem Grübchen (Abb. 125). Bt am Hlb 9 häkchenförmig, gleich denen am Hlb 10 (Abb. 120, 127). Bre der D am Hlb 2–7 teilweise mehrfach (Abb. 138) | 2 |
| – | Vbr ohne ein Grübchen. Bt am Hlb 9 fast immer borstenförmig, Häkchen am Hlb 10 haken-, seltener borstenförmig (Abb. 9, 72, 75). Bre der D am Hlb 2–7 einfach (vgl. Abb. 139) | 3 |

- 2(1) Stirn mit einem stumpfen Fortsatz (Abb. 126). Am Hlb 4–6 Gruppe VII aus 4 Bt (Abb. 138) 10. *Petrova*
 – Stirn abgerundet, ohne Fortsatz Am Hlb 4–6 Gruppe VII aus 3 Bt (vgl. Abb. 136) 9. *Blastetha*
- 3(1) Hlb 10 mit 4 Paaren von Peh (Abb. 141, 143). Hinter dem Luftloch am Hinterleib je eine isolierte Bt 4a (Abb. 136). Stirn mit einem Fortsatz (Abb. 126, 135–137) . 4
 – Hlb mit 1–3 Paaren (Abb. 87, 111, 118), selten ohne (Abb. 57, 58) Peh. Am Hlb 4–8 fehlt die Bt 4a (vgl. Abb. 138). Stirn ohne-, seltener mit einem Fortsatz . 5
- 4(3) Seitendornen am Hlb 10 viel grösser als die Rückendornen (Abb. 143). Stirnfortsatz spitzig, kegelförmig (Abb. 145). P rd. 7×2 mm 12. *Clavigesta*
 – Seitendornen am Hlb 10 kaum grösser als die Rückendornen (Abb. 141). Stirnfortsatz stumpfer (Abb. 126), – abgeflacht (Abb. 135), wenn spitzig (und auch meist sonst) P grösser, wenigstens $8 \times 2,2$ mm 11. *Rhyacionia*
- 5(3) Mit 3 Paar von Peh (Abb. 118). P rel. gross, dunkel rotbraun, Kpe gerunzelt (Abb. 117) 8. *Barbara*
 – Mit 1–2 Paar (Abb. 66, 69) selten ohne (Abb. 57, 58) Peh. P meist kleiner bezw. heller 6
- 6(5) Hlb 10 mit 4 Paar von Eh und 2 Paar von Peh (Abb. 5, 23). Kr oft ziemlich entwickelt (Abb. 6, 10, 14) 1. *Ancylis*
 – Hlb 10 nur mit 1–3 Paar von Eh (Abb. 57, 62, 69). Wenn 4 Paar vorhanden, gibt es (wie auch sonst oft) nur 1 Paar von Peh (Abb. 87). Kr \pm reduziert (Abb. 44, 50) 7
- 7(6) D der Kre am Hlb 2–7 stark kammartig (leistenartig nach hinten fortgesetzt – Abb. 99 – mit Rinnen dazwischen). Hlb 10 mit 3 Paar von Eh und 2 Paar von Peh (Abb. 106), Stirn ohne Fortsatz 6. *Epiblema*
 – D am Hlb 2–7 nicht kammartig; wenn doch etwas, dann nicht zugleich 3 Paar von Eh und 2 Paar von Peh, bezw. Stirn mit einem Fortsatz (Abb. 74, 77) 8
- 8(7) Hlb 10 mit 4 Paar von Eh und 1 Paar von Peh (Abb. 87). D auffallend stark 4. *Zeiraphes*
 – Hlb 10 mit 1–3 Paar von Eh und 0–2 Paar von Peh (Abb. 57, 52, 111). D oft mittelstark oder schwach 9
- 9(8) Hlb 10 mit 2 Paar von Peh (Abb. 68, 95, 111) 10
 – Hlb 10 mit 1 Paar oder die Peh fehlen (Abb. 49, 57), zuweilen sind sie auch borstenförmig 2. *Epinotia* p. p
- 10(9) Mit 2 Paar von Eh (Abb. 110) 7. *Spilonota*
 – Mit 3 Paar von Eh (Abb. 67) 11
- 11(10) D am Hlb 10 nicht oder kaum grösser als die am Hlb 9 (Abb. 94). Am Hlb 4 zwischen den Rbt gibt es mehr als 25 D der Kre 5. *Gypsonoma*
 – D am Hlb 10 deutlich-, bezw. viel grösser als am Hlb 9 (Abb. 67, 81). Am Hlb 4 zwischen den Rbt höchstens 20 D der Kre 12
- 12(11) Am Hlb 4 zwischen den Rbt weniger als 15 D. der Kre. Hbr mehr als zu $\frac{1}{2}$, ausgeschnitten 3. *Rhopobots*
 – Am Hlb 4 zwischen den Rbt mehr als 15 D der Kre. Hbr kaum zu $\frac{1}{2}$, ausgeschnitten 2. *Epinotia* p. p

1. Gattung *Ancylis* Hübner, 1825

Mittelgrosse bis kleinere, beim σ rel. schlanke P nicht einheitlich gebaut. Stirn zwischen den F. stark, hoch vorgezogen (Abb. 1) selten ausserdem mit einer beulenförmigen Erhabenheit. Kr. klein, aber meist deutlich erhalten, ventral gerunzelt. Bt rel. gross, Gruppe VII mit 3 Bt am Hlb 4–6 und 2 Bt am Hlb 7–9. Hlb 10 mit 4 Paar von Eh und 2 Paar von Peh.

Die Raupen leben zwischen den für eine jede Art charakteristisch versponnenen Blättern der Laubbölder oder in einer Blattbiegung. Verpuppung im Gehäuse der Raupe. Es überwintert meist eine Praepupa, welche gewöhnlich mit einem abfallenden Blatt zum Boden gelangt um sich im Frühling zu verpuppen. Manchmal 2 Generationen im Jahre. Wirtschaftlich sind die Arten ziemlich belanglos.

Bestimmungstabelle der Arten (Es fehlen noch *A. geminana* Donovan, 1806, *A. obtusana* Haworth, 1811, *A. selenana* Guenée, 1845 und *A. tineana* Hübner, 1796—1799.)

- | | | |
|------|--|----------------------------|
| 1 | Stirn mit beulenförmiger Erhabenheit | <i>A. upupana</i> |
| - | Stirn ohne solche Erhabenheit, nur zwischen den F schmal, stark vorgezogen (Abb. 1) | 2 |
| 2(1) | Im Basalteil von Hlb 2—4 dorsal je eine tiefe, mit scharfer Hinterkante versehene Querrinne (Abb. 12, 16). D der Bre kaum grosser als die der Kre | 3 |
| - | Im Basalteil von Hlb 2—4 höchstens eine seichte Rinne ohne scharfe Hinterkante. D der Bre viel grosser als die der Kre | 4 |
| 3(2) | Die Rinne am Hlb 2—3 in der Mitte überbrückt (Abb. 16) | <i>A. unculana</i> |
| - | Die Rinne am Hlb 2—3 nicht überbrückt. Ihre Hinterkante bildet einen gezähnten Bogen (Abb. 12) | <i>A. achatana</i> |
| 4(2) | Kr kurz, abgestumpft. Mittlere ventrale Eh weit voneinander entfernt (Abb. 18, 19) | <i>A. apicella</i> |
| - | Kr rel. länger, ± abgerundet, bezw. zugespitzt, mittlere ventrale Eh näher beieinander entspringend (Abb. 4, 22) | 5 |
| 5(4) | Hbr tiefer als zu $\frac{1}{2}$ ausgeschnitten, mit rel. starken Leistengebilden (Abb. 27). Dornreihe am Hlb 10 und meist auch am Hlb 9 mehrfach (Abb. 22, 24) | <i>Epinotia festivana</i> |
| - | Hbr etwa zu $\frac{1}{2}$ ausgeschnitten, ohne deutliche Leistengebilde Dornreihe am Hlb 10 und 9 einfach, selten nur teilweise verdoppelt (Abb. 4—7) | 6 |
| 6(5) | Kr rel. grosser, Eh stärker. D am Hlb 10 rel. gross, nicht kleiner als die am Hlb 8 und 9 (Abb. 4) | <i>A. laetana</i> |
| - | Kr rel. kleiner, Eh feiner. D am Hlb 10 winzig, kleiner als die am Hlb 8 und 9 (Abb. 7) | <i>A. mitterbacheriana</i> |

1. *Ancylis laetana* (Fabricius, 1775)

P 7—8 × 2—2,3 mm (1 ♂ und 1 ♀), hell rötlich braun, Exuvie rötlich gelbbraun. Stirn zwischen den F stark hervortretend (Abb. 1), F mittellang, Ol trapezförmig, Zunge kaum 2× länger als die Ol. Vfl mit angedeuteten Adern, Spitze rel. breit (Abb. 2). Hbr rd. zu $\frac{1}{2}$ ausgeschnitten, Leisten kaum sichtbar. Hlb 1 dornlos, D am Hlb 2 ziemlich ähnlich denen am Hlb 3, D mittelstark, die der Bre viel stärker als die der Kre. Am Hlb 4 zwischen den Rbt gibt es 4—5 D der Bre und 14—22 der Kre (beim ♂ mehr als beim ♀). Kre am Hlb 8 vorhanden oder fehlend. D am Hlb 10 etwa so gross wie am Hlb 8 und 9, kleiner als die der Bre am Hlb 4. Eh rel. stark. Kr stumpf abgerundet, ventral gerunzelt (Abb. 3—5).

Raupe an *Populus*, insbes. *P. tremula* im umgeschlagenen Blattrand oder zwischen taschenartig versponnenen Blättern.

2. *Ancylis mitterbacheriana* (Denis et Schiffermüller, 1775) P 6—8 × 1,8—2,1 mm (2 ♂♂, 1 ♀) gelbbraun (♂) oder braun (♀), Exuvie heller. Morphologisch *A. laetana* ähnlich. Am Hlb 4 gibt es 5—6 D der Bre und 15—18 D der Kre zwischen den Rbt. Kr kleiner, dorsal nicht gerunzelt. D am Hlb 10 in einfacher Reihe, sehr klein, kleiner als am Hlb 8 und 9. Häkchen kleiner als bei *A. laetana*.

Raupe an *Quercus*, *Castanea* und *Fagus* in einem länglich nach oben umgeschlagenen Blatt.

3. *Ancylis upupana* (Treitschke, 1835)

P (1 ♂) so gross wie bei *A. mitterbacheriana*, rotbraun. Stirn zwischen den F hervortretend und ausserdem mit einer beulenförmigen Erhabenheit. Hbr mehr als zu $\frac{1}{2}$ ausgeschnitten. D rel. stark, am Hlb 4 nur 3 D der Bre zwischen den Rbt. D am Hlb 10 in einfacher Reihe, nicht kleiner als die am Hlb 8 und 9.

Kr kurz, dorsal polygonalventral mehr länglich gerunzelt. Eh stark, keulenformig.

Raupe hauptsächlich an *Ulmus* zwischen übereinander versponnenen Blättern.

4. *Ancylus achatana* (Denis et Schiffermüller, 1775)

P 8—9 × 2—2,5 mm (1 ♂, 2 ♀♀), dunkel rotbraun, Exuvie rotbraun. Stm erhaben, schwarzlich. Clypeus gerunzelt. Zunge rd. 2 × länger als die Ul. Hbr

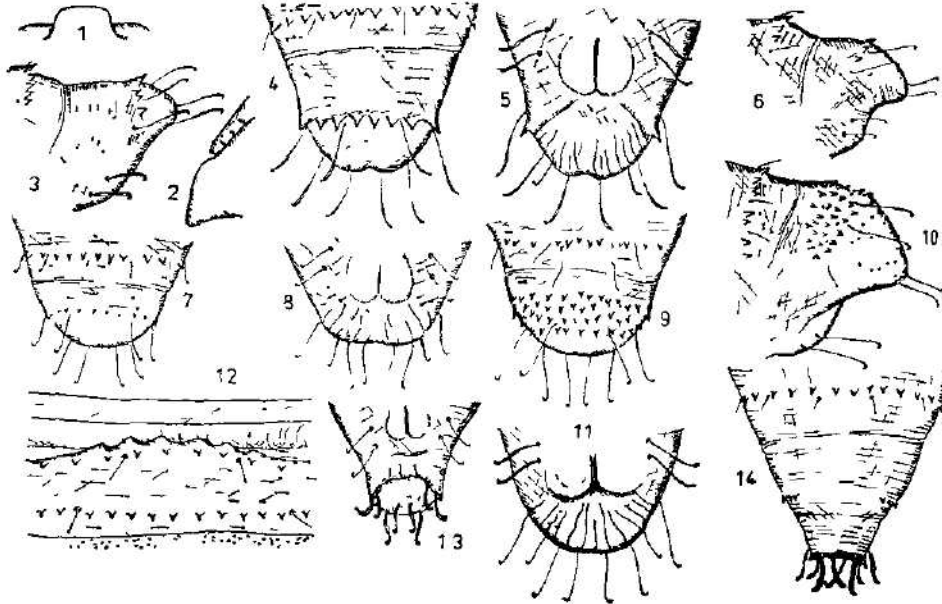


Abb 1—5 *Ancylus laetana*: 1 — Stern, 2 — Spitze der VI, 3 — Hlb 9—10 von der Seite, 4 — von oben, 5 — Hlb 10 von unten Abb 6—8 *A. mitterbacheriana*: 6 — Hlb 9—10 von der Seite, 7 — von oben, 8 — Hlb 10 von unten Abb 9—12 *A. achatana*: 9 — Hlb 9—10 von oben, 10 — von der Seite, 11 — Hlb 10 von unten, 12 — Hlb 3, Basalteil Abb 13—14 *A. unculana*: 13 — Hlb 10 von unten, 14 — Hlb 9—10 von oben

kaum zu $\frac{1}{2}$ ausgeschnitten, Leisten schwach. An der Basis von Hlb 2—7 vor der Bre der D gibt es eine starke Querrinne mit gezackelter Hinterkante (Abb. 12). Am Hlb 2—3 die D schwach, am Hlb 4—7 stärker, aber auch klein, breit, die der Bre und Kre fast gleichgross. Am Hlb 4 zwischen den Rbt gibt es 4—5 D der Bre und 9—12 denen der Kre. D am Hlb 8—10 so gross wie die der Bre am Hlb 4, nur in einer Reihe, die am Hlb 10 und manchmal auch am Hlb 9 mehrfach (Abb. 9, 10). Bt rel. stark. Kr rel. gros, rauh skulpturiert und ventral stark gerunzelt. Håkchen mittelstark (Abb. 9—11).

Raupe hauptsächlich an *Crataegus* (auch an *Prunus* u. a.) in einem Gehäuse aus Blättern, die zum Zweig zugesponnen sind. Es überwintert wohl die junge Raupe. Verpuppung im Gehäuse.

5. *Ancylus unculana* (Haworth, 1811)

P 7 × 2 mm (1 ♀) braunschwarz, Exuvie schwarzbraun, Vfl. rel. spitzig. Hbr sehr tief (fast zu $\frac{3}{4}$) ausgeschnitten, Leistengebilde rel. stark. An der Basis

von Hlb 2—7 gibt es starke Querrinnen, die am Hlb und 3 bzw. teilweise auch —4 in der Mitte überbrückt sind (Abb. 16). Ihre Kanten stark hervortretend, schwärzlich. D schon am Hlb 2 deutlich, rel. klein, die der Bre und Kre fast gleichgross. Am Hlb 8 zwei Dornreihen. Am Hlb 10 die D verkümmert und fast-, bzw. ganz fehlend (Abb. 14, 15). Kr rel. lang, kegelförmig, am Ende abgestutzt, fast glatt, ventral mit angedeuteten Runzeln. Eh kurz, dick, Peh kaudalwärts verschoben (Abb. 13—15).

Raupe an *Rhamnus*, auch *Frangula* unter einem umgeschlagenen Blattrand.

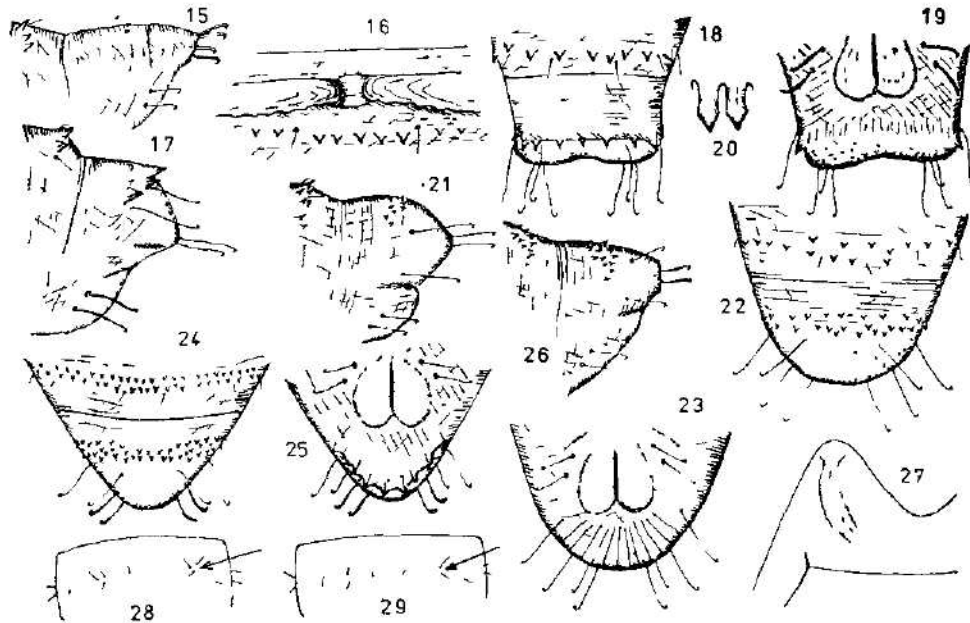


Abb 15—16 *A. unculana*: 15 — Hlb 9—10 von der Seite, 16 — Hlb 3, Basalteil Abb 17—20 *A. apicella* 17 — Hlb 9—10 von der Seite, 18 — von oben, 19 — Hlb 10 von unten, 20 — D der Bre am Hlb 2 Abb 21—23 *Epinotia festivana*, ♂ 21 — Hlb 9—10 von der Seite, 22 — von oben, 23 — Hlb 10 von unten Abb 24—27 *E. festivana*, ♀ 24 — Hlb 9—10 von oben, 25 — Hlb 10 von unten, 26 — Hlb 9—10 von der Seite Abb 27 *L. pygmaeana*: Hlb 7 von unten Abb 29 *E. tedella* Hlb 7 von unten

6 *Ancylis apicella* (Denis et Schiffermüller, 1775)

P 7 × 1,7 mm (1 ♂), schlank, rötlich braun, vorn dunkler, Exuvie hellbraun, Hlb 1—3 verdunkelt. Zunge rd 2 × länger als die Ul. Hbr. kaum zu $\frac{1}{2}$ ausgeschnitten mit undeutlichen Leistengebilden. D am Hlb 2 so gross wie an den folgenden Ringen D der Bre am Hlb 2 und 3 breit mit einer Dorsalkante (Abb. 20) D der Bre viel grösser als die der Kre. Am Hlb 4 gibt es zwischen den Rbt 4 D der Bre und 12 D der Kre Hlb 8 nur mit einer Dornreihe. Hlb 10 abgestutzt, sogar etwas konkav, breit, Kr kaum entwickelt Hakenchen fein, die mittleren ventralen Eh weit voneinander entfernt. (Abb. 17—19). Bt rel. deutlich.

Raupe an *Frangula*, auch *Rhamnus*, zwischen versponnenen Blättern.

2. Gattung *Epinotia* Hübner, 1825

P uneinheitlich, klein bis rel. gross, rotbraun bis gelbbraun gefärbt, mässig glänzend. Stirn sehr schwach bis stark zwischen den F hervorstehend, manchmal auch mit einem Fortsatz. Rel. Länge der F. und Zunge variieren zwischen den Arten aber auch Geschlechtern, ähnlich auch die Spitze der Vf. Hbr zu kaum $\frac{1}{2}$ bis $\frac{2}{3}$ meist breit ausgeschnitten, Leistengebilde fehlend bis ziemlich stark. Hlb 1 dornlos. D rel. klein bis gross, am Hlb 2 oft kleiner und auch breiter als an folgenden Ringen. D der Bre steiler und deutlich bis viel grösser als die der Kre. Selten sind die Dornreihen etwas kammförmig. Kre der D (insbes. bei den ♀♀) oft auch am Hlb 8 vorhanden, Dornreihe am Hlb 10 einfach, selten, mehrfach, D dort so gross bis deutlich grösser als die am Hlb 8 und 9. Bt sehr schwach bis stark, Gruppe VII am Hlb 4—6 (selten auch 7) drei-, am Hlb 7—9 zweiborstig. Hlb 10 mit 2—3 (ausnahmsweise 1 oder 4) Paaren von Eh und 1 (selten 2) denen von Peh. Häkchen meist haken- selten borstenförmig. Kr fehlt praktisch, die Kpe aber meist \pm gewölbt, rel. rauh skulpturiert, ventral oft gerunzelt, Ventralante oft deutlich und manchmal auch gezähnt.

Aus dem erwähnten geht die Heterogenität der P dieser Gattung hervor. Die Art *E. festivana* macht überhaupt einen recht fremdartigen Eindruck und sollte wohl eher in eine gesonderte Gattung zwischen *Epinotia* und *Ancylis* abgeteilt werden. *E. cruciana* ist puppenmorphologisch eher der Gattung *Rhopobota* oder *Gypsonoma* ähnlich. Auch *E. pusillana* unterscheidet sich stark von den übrigen. Laut Bradley et al. (1972) wird die Gattung in mehrere Untergattungen geteilt, welche meistens auch puppenmorphologisch zu charakterisieren sind: Untergattung *Asthenia* Hübner, 1825 — Gruppe VII am Hlb 7 dreiborstig.

Untergattung *Evetria* Hübner, 1825 (Syn. *Steganoptycha* Stephens, 1829) — Gruppe VII am Hlb 7 zweiborstig, mit 2 Paar von Eh, diese meist hakenartig. Stirn abgerundet. Zerfällt in zwei Gruppen, eine mit flacher Stirn und zahlreichen D zwischen den Rbt, vorwiegend an Nadelhölzern, die andere mit hervorstehender Stirn und weniger zahlreichen D zwischen den Rbt, vorwiegend von Laubhölzern.

Untergattung *Hamuligera* Obratzov, 1946 — 3 Paar von Eh, Stirn abgerundet. Hierher würde aber puppenmorphologisch eher auch *E. stroemiana* gehören.

Untergattung *Epinotia* Hübner, 1825 — gross, 3 Paar von Eh, Stirnforsatz, Starke Leisten an der M- und Hbr.

Die Raupen leben verschiedenartig und überwintern meistens. Verpuppung am Boden, in einem Erdkokon, nur bei *E. festivana* an Blättern.

Bestimmungstabelle der Arten (Es fehlen noch: *E. solandriana* Linnaeus, 1758, *E. brunnichana* Linnaeus, 1767, *E. maculana* Fabricius, 1775, *E. bilunana* Haworth, 1811, *E. demarniana* Fischer von Röslerstamm 1839, *E. rammella* Linnaeus, 1758, *E. granitana* Herrich Schäffer, 1848, *E. rubiginosana*, Herrich Schäffer, 1848, *E. crenana* Hübner 1814—1817, *E. subsequana* Haworth, 1811.)

| | | |
|------|---|---------------------|
| 1. | Dornreihe am Hlb 10 mehrfach. Mit 4 Paar von Eh. Kr rel. deutlich (Abb. 22—26) | <i>E. Festivana</i> |
| — | Dornreihe am Hlb 10 einfach. Mit 1—3 Paar von Eh. Kr kaum oder nicht entwickelt (Abb. 59, 61, 71) | 2 |
| 2(1) | Stirn mit einem Fortsatz (Abb. 54, 74, 78) | 3 |
| — | Stirn abgerundet, ohne einen Fortsatz | 5 |
| 3(2) | 1 Paar von Eh und keine Peh (Abb. 57, 58). P. klein | <i>E. pusillana</i> |
| — | 3 Paar von Eh (Abb. 75, 79). P rel. gross | 4 |

| | | | |
|--------|--|-----------------------|----|
| 4(3) | Fortsatz zweispitzig (Abb. 74). Eh und Peh borstenförmig (Abb. 76) | <i>E. sordidana</i> | |
| - | Fortsatz einspitzig, stumpf (Abb. 78). Eh und Peh hakenförmig (Abb. 79) | <i>E. caprana</i> | |
| 5(2) | Mit 2 Paar von Peh (Abb. 68, 69) | <i>E. cruciana</i> | 6 |
| - | Mit 1 Paar von Peh (Abb. 35) | | 7 |
| 6(5) | Mit 3 Paar von Eh (Abb. 65, 71) | | 8 |
| - | Mit 2 Paar von Eh (Abb. 43) | | |
| 7(6) | P 5-6,5 × 1,5-2 mm. Am Hlb 4 zwischen den Rbt gibt es 4-6 D der Bre. Bt mittelstark (Abb. 65) | <i>E. abbreviana</i> | |
| - | P 7-7,5 × 2-2,5 mm. Am Hlb 4 zwischen den Rbt gibt es 6-8 D der Bre. Bt lang, stark (Abb. 71) | <i>E. stroemiana</i> | |
| 8(6) | Am Hlb 7 die Gruppe VII dreiborstig. Eh borstenförmig | <i>E. pygmaeana</i> | |
| - | Am Hlb 7 die Gruppe VII zweiborstig (Abb. 29). Eh meistens hakenförmig | | 9 |
| 9(8) | Ventralkante der Kpe stark, mit zahnartigen Gebilden (Abb. 40, 62) | | 10 |
| - | Ventralkante der Kpe ohne zahnartige Gebilde (Abb. 33), bezw rückgebildet (Abb. 49) | | 11 |
| 10(9) | Am Hlb 4 zwischen den Rbt gibt es 5-6 D der Bre und 17-20 D der Kre | <i>E. signatana</i> | |
| - | Am Hlb 4 zwischen den Rbt gibt es 4-5 D der Bre und 12-14 D der Kre | <i>E. nitella</i> | |
| 11(9) | Am Hlb zwischen den Rbt gibt es 6-10 D der Bre und 16-25 D der Kre. Stirn zwischen den F kaum oder schwach erhaben (Abb. 42, 46). An Nadelhölzern | | 12 |
| - | Am Hlb 4 zwischen den Rbt gibt es 4-5 D der Bre und 10-16 D der Kre. Stirn deutlich erhaben (Abb. 30). An Laubhölzern | | 15 |
| 12(11) | Kpe gewölbt. Seitendornen am Hlb 10 nicht grösser als die Rückendornen (Abb. 44, 53) | | 13 |
| - | Kpe kaum gewölbt, zuweilen etwas konkav. Seitendornen am Hlb 10 deutlich grösser als die Rückendornen (Abb. 46, 48, 50) | | 14 |
| 13(12) | Zunge wenigstens 2 × länger als die Ul. Am Hlb 4 gibt es 20-25 D der Kre zwischen den Rbt. P rel grösser und gedrungener, an Tannen | <i>E. nigricana</i> | |
| - | Zunge weniger als 2 × länger als die Ul. Am Hlb 4 gibt es 16-20 D der zwischen den Rbt. An Fichten | <i>E. nanana</i> | |
| 14(12) | Eh hakenartig (Abb. 19). An Fichten | <i>E. tedella</i> | |
| - | Eh borstenartig (Abb. 49, 50). An Tannen | <i>E. fraternana</i> | |
| 15(11) | P gelbbraun, Exuvie bleich braungelb. D am Hlb 2 deutlich kleiner als die am Hlb 3 | <i>E. subocellana</i> | |
| - | P rotbraun, Exuvie heller rotbraun. D am Hlb 2 kaum kleiner als am Hlb 3 | | 16 |
| 16(15) | Spitze der Vfl scharf (Abb. 41). Am Hlb 3-7 D der Bre deutlich grösser als die der Kre | <i>E. tenerana</i> | |
| - | Spitze der Vfl stumpf (Abb. 37). D der Bre wenig grösser als die der Kre | | 17 |
| 17(16) | Am Hlb 4 zwischen den Rbt gibt es 11-14 D der Kre. Hbr wenigstens zu $\frac{1}{3}$, ausgeschnitten. Ventralseite der Kpe nicht oder schwach gerunzelt | <i>E. tetraquetra</i> | |
| - | Am Hlb 4 zwischen den Rbt gibt es 14-16 D der Kre. Hbr kaum zu $\frac{1}{3}$, ausgeschnitten. Ventralseite der Kpe deutlicher gerunzelt (Abb. 35) | <i>E. immundana</i> | |

1. *Epinotia* (*Epinotia*) *festivana* (Hübner, 1796-1799)

P 7-8 × 2-2,3 mm (10 P), ♀ gedrungener, Färbung rötlich gelbbraun, Exuvie heller. Stirn zwischen den F stark erhaben (vgl. Abb. 1). F rel kurz. Zunge kaum 2 × länger als die Ul. Vfl ziemlich spitzig. Hbr zu mehr als $\frac{1}{2}$ (♂) oder zu $\frac{2}{3}$ (♀) ausgeschnitten mit deutlichen Leistengebilden (Abb. 27). D am Hlb 2 ähnl. wie am Hlb 3. D mittelgross, die der Bre steiler und deutlich grösser als die der Kre. Am Hlb 4 gibt es 4-5 D der Bre und 12-16 D der Kre zwischen den Rbt. D am Hlb 10 viel kleiner als die der Bre am Hlb 4. Am Hlb 10 (aber insbes. beim ♀ oft auch am Hlb 9 und 8) die Dornreihe mehrfach (Abb. 22, 24). Am Hlb 8 die Kre meist vorhanden. Mit 4 Paar von Eh, beim ♂ schlank, beim ♀ dick, und 2 Paar von Peh. Hlb 10 beim ♀ spitziger, mit kurzem Kr. ventral gerunzelt, die Runzelung beim ♂ länglich, beim ♀ quer (Abb. 23, 25).

Raupe überwintert in den Eichentrieben, übergeht dann in die diesjährigen-, welche gallenartig anschwellen (vgl. Zocchi, 1959). Verpuppung am Blatt unter einem ausgeschnittenen Blatteil.

2. *Epinotia (Asthenia) pygmaeana* (Hübner, 1796—1799)

In der Grösse etwa der *E. tedella* entsprechend, hellbraun mit mittelgrossen, am Hlb 10 rel. starken D. Gruppe VII am Hlb 7 dreiborstig. Mit 2 Paar von

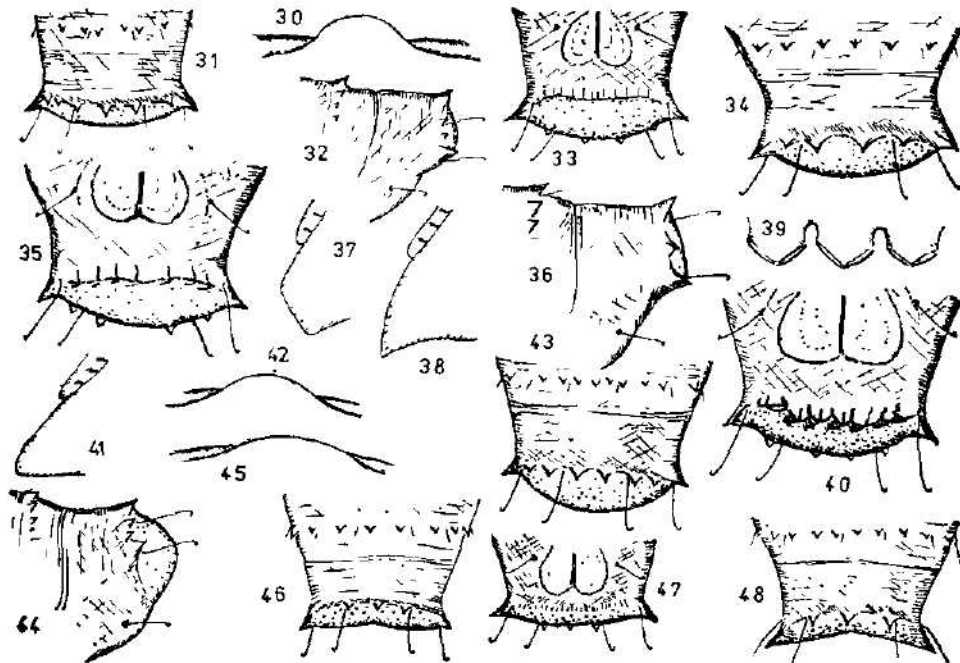


Abb. 30–33: *E. subocellana*: 30 – Stirn, 31 – Hlb 9–10 von oben, 32 – von der Seite, 33 – Hlb 10 von unten. Abb. 34–37: *E. immundana*: 34 – Hlb 9–10 von oben, 35 – Hlb 10 von unten, 36 – Hlb 9–10 von der Seite, 37 – Spitze der Vfl. Abb. 38–40: *E. nisella*: 38 – Spitze der Vfl, 39 – D der Kre am Hlb 2, 40 – Hlb 10 von unten. Abb. 41: *E. tenerana*: Spitze der Vfl. Abb. 42–44: *E. nigricana*: 42 – Stirn, 43 – Hlb 9–10 von oben, 44 – von der Seite. Abb. 45–47: *E. tedella*: 45 – Stirn, 46 – Hlb 9–10 von oben, 47 – Hlb 10 von unten. Abb. 48: *E. fraternana*: Hlb 9–10 von oben.

Eh und 1 Paar von Peh, die borstenförmig sind (vgl. Swatschek, 1958; Escherich III, 1931. Schwenke et al. 3 1978).

Die Raupe miniert und später befrisst und verspinnt die jungen Nadeln von *Picea*. Verpuppung in der Waldstreu in einem Erdkokon, Puppe überwintert.

3. *Epinotia (Evetria) subocellana* (Donovan, 1806)

P 5,5–6,2 × 1,5–1,8 mm (1 ♂ und 1 ♀), gelbbraun, Exuvie bleich braungelb. Stirn zwischen den F mittelstark erhaben (Abb. 30). F rel. lang. Ol abgerundet trapezförmig, Zunge kürzer als die doppelte Länge der Ul. Spitze der Vfl abgerundet scharfwinklig. Hbr rd. zu $\frac{1}{2}$ ausgeschnitten, Leiste undeutlich. D am

Hlb 2 kleiner als am Hlb 3. Am Hlb 3—7 die D mittelgross, die der Bre deutlich grösser als die der Kre. Am Hlb 4 gibt es 5 D der Bre und 12—14 denen der Kre zwischen den Rbt. D am Hlb 8—9 nicht kleiner als die der Bre am Hlb 4, D am Hlb 10 deutlich grösser, Reihe einfach, Seitendornen nicht grösser als die Rückendornen. 2 Paar von Eh und 1 Paar von Peh fein. Kpe wenig gewölbt, Ventralkante deutlich, davor fein längsgerunzelt (Abb. 31—33).

Raupe zwischen versponnenen Blättern von *Salix caprea*, *S. aurita*, *S. cinerea*, Verpuppung im Frühling, seltener schon im Herbst i einem Erdkokon.

4. *Epinotia (Evetria) immundana* (Fischer v. Röslerstamm, 1839)

P rel. gedrungen, 6,5—7×1,8—2 mm (1 ♂ und 1 ♀), rotbraun, Exuvie heller. Morphologisch der vorigen ziemlich ähnlich. Spitze der Vfl breit, am Ende rel. scharf (Abb. 37). Hbr kaum $\frac{1}{2}$ ausgeschnitten. D am Hlb 2 kaum kleiner als die am Hlb 3, D mittelgross, die der Bre etwas grösser und steiler als die der Kre. Am Hlb 8 gibt es 5 D der Bre und 14—16 D der Kre zwischen den Rbt. D am Hlb 10 deutlich grösser als die am Hlb 8—9. 2 Paar von Eh und 1 Paar von Peh rel. fein. Kpe mässig gewölbt, Ventralkante deutlich, Runzelung fein, dünn (Abb. 34—36).

Raupe überwintert, lebt in ♂ Kätzchen bezw. Knospen der Erle (seltener der Birke), 2. Gen. in versponnenen Blättern. Verpuppung in einem Erdkokon am Boden.

5. *Epinotia (Evetria) tetraquetra* (Haworth, 1811)

P (6 P) der vorigen sehr ähnlich, Hbr tiefer ausgeschnitten, am Hlb 4 gibt es 5—8 D der Bre und 11—14 D der Kre zwischen den Rbt. Eh dicker und mehr keulenförmig. Ventralseite der Kpe nicht oder schwach gerunzelt.

Raupe lebt im Sommer in gallenartig verdickten Trieben von Birken und Erlen, später in versponnenen Blättern. P überwintert in einem Erdkokon am Boden.

6. *Epinotia (Evetria) nisella* (Clerck, 1759)

P (1 ♂, 2 ♀♀) den vorigen ähnlich. Hbr zu mehr als $\frac{1}{2}$ ausgeschnitten. Am Hlb 2 die D der Kre (insbes. beim ♀) sehr breit (Abb. 39). D im allgemeinen rel. grösser als bei den vorigen. Am Hlb 4 gibt es 4—5 D der Bre und 12—14 denen der Kre zwischenden Rbt. Häkchen bleich, ziemlich keulenförmig. Kpe mit starker Ventralkante die mit \pm zahnartigen Leisten und starken Runzeln versehen ist (Abb. 40).

Raupe überwintert in Kätzchen von Pappeln (seltener Salweiden) spinnt den Flaum zusammen, verspinnt und befrisst auch benachbarte junge Blättchen im Frühling. Verpuppung in einem Erdkokon am Boden.

7. *Epinotia (Evetria) tenerana* (Denis et Schiffermüller, 1775)

E. tetraquetra sehr ähnlich (10 P), Vfl spitzwinkelig (Abb. 41). Am Hlb 4 gibt es 4—5 D der Bre und 14—19 D der Kre zwischen den Rbt. D der Bre deutlich grösser als die der Kre. Ventralkante der Kpe oft doppelt, Längsrunzelung der Ventralseite fehlt.

Raupe in männlichen Kätzchen von *Corylus*, auch *Alnus*, überwintert, im Frühling auch in treibenden Knospen, Verpuppung in einem Kokon am Boden.

8. *Epinotia (Evetria) nigricana* (Herrich-Schäffer, 1851)

P (vgl. Patočka et al., 1980) 4–6 × 1,2–2 mm (10 P) gelbbraun, Exuvie heller. Stirn zwischen der F ziemlich breit, mässig erhaben (Abb. 42). F mittel-lang. Zunge weit wenigstens 2 × länger als die Ul. Spitze der Vfl beim ♂ spitzig, beim ♀ stumpfer. Hbr etwa zu $\frac{1}{2}$ ausgeschnitten, Leisten nur angedeutet. D rel. klein, am Hlb 2 etwas kleiner als am Hlb 3, D der Bre deutlich grösser als die der Kre. Am Hlb 4 gibt es 7–10 D der Bre und 20–25 D der Kre zwischen den Rbt. Am Hlb 8 fehlt die Kre der D. D am Hlb 8 und 9 wenigstens so gross

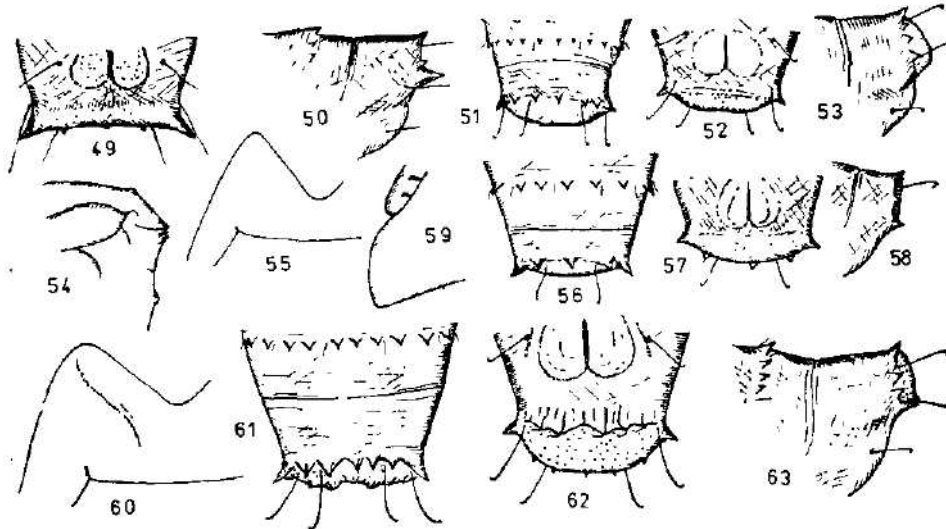


Abb. 49–50. *E. fraternana*: 49 – Hlb 10 von unten, 50 – Hlb 9–10 von der Seite. Abb. 51–53. *E. nanana*: 51 – Hlb 9–10 von oben, 52 – Hlb 10 von unten, 53 – Hlb 9–10 von der Seite. Abb. 54–58. *E. pusillana*: 54 – Kopf von der Seite, 55 – Hbr, 56 – Hlb 9–10 von oben, 57 – Hlb 10 von unten, 58 – Hlb 9–10 von der Seite. Abb. 59–63. *E. signatana*: 59 – Spitze der Vfl, 60 – Hbr, 61 – Hlb 9–10 von oben, 62 – Hlb 10 von unten, 63 – Hlb 9–10 von der Seite.

wie die der Bre am Hlb 4, D am Hlb 10 grösser als diese, Seitendornen dort nicht grösser als die Rückendornen. Bt sehr fein. Hlb 10 mit 2 paar rel. starker Eh und 1 Paar von Peh. Laterale Eh entspringen ventral von den Seitendornen. Kpe deutlich gewölbt, kaum gerunzelt (Abb. 43, 44).

Die Raupe überwintert in den Tannenknospen (jung, im Sommer, verzehrt sie abgestorbene Knospenteile). Verpuppung in der Waldstreu in einem Erdkokon. Manchmal ein Forstschädling.

9. *Epinotia (Evetria) tedella* (Clerck, 1759)

P 3–5 × 1,1–1,6 mm (10 P) hellbraun, Exuvie blasser, Stirn zwischen der F breit, schwach gewölbt (Abb. 45). Sonst morphologisch *E. nigricana* ähnlich. F ziemlich lang. Spitze der Vfl schlank, aber rel. stumpf. Hbr kaum zu $\frac{1}{2}$ ausgeschnitten mit undeutlichen Leisten, D am Hlb 2 kleiner als die am Hlb 3. Am Hlb 3–7 D der Bre deutlich grösser als die der Kre. Am Hlb 4 gibt es 6–8 D der Bre und 17–22 D der Kre zwischen den Rbt. Am Hlb 10 D grösser als die

am Hlb 8—9 und die Seitendornen deutlich grösser als die Rückendornen. Bt sehr fein. Eh fein, hakenförmig, die lateralen entspringen von der Innenseite der Seitendornen. Kpe kaum gewölbt, ofte etwas konkav, ohne Ventralkante (Abb. 46, 47).

Raupe miniert und verspinnt (manchmal auch befrisst) die Fichtennadeln, überwintert als Praepupa in einem Erdkokon in der Waldstreu, verpuppt sich im Frühling. Ein Forstschädling.

10. *Epinotia (Evetria) fraternana* (Haworth, 1811)

P (2 ♂, 1 ♀) der von *E. tedella* sehr ähnlich, D rel. etwas stärker, insbes. die Seitendornen am Hlb 10 kräftig. Am Hlb 4 gibt es 8 D der Bre und 18—20 D der Kre zwischen den Rbt. Eh und Peh haarförmig. Laterale Eh entspringen von der Aussenseite der Seitendornen (Abb. 48—50). Kpe meist konkav, Ventralkante fehlend.

Raupe miniert und verspinnt die Nadeln der Tanne (Patočka et al., 1960). Sie überwintert und verpuppt sich ähnlich wie *E. tedella*.

11. *Epinotia (Evetria) nanana* (Treitschke, 1835)

P 3—5 × 1—1,5 mm (6 P), rel. schlank, gelbbraun, Exuvie blass braungelb. Stirn rel. breit und wenig gewölbt. Zunge kürzer als die doppelte Länge der Ul., F rel. lang, Vfl. mit abgestumpfter Spitze. Hbr. kaum zu $\frac{1}{2}$ ausgeschnitten. D rel. schwach, wenig steil, ein bisschen kammartig, am Hlb 2 kleiner als am Hlb 3. Am Hlb 3—7 die D der Bre viel grösser als die der Kre. Am Hlb 4 zwischen den Rbt gibt es 6—10 D der Bre und 16—20 D der Kre. D am Hlb 10 deutlich grösser als die am Hlb 8 und 9, Seitendornen nicht vergrössert. Bt fein. 2 Paar von Eh und 1 Paar von Peh deutlich, hakenförmig. Laterale Eh entspringen ventral von den Seitendornen. Kpe deutlich gewölbt, mässig skulpturiert, mit schwacher Ventralkante (Abb. 51—53).

Raupe miniert und verspinnt die alten Nadeln der Fichten, überwintert jung, verpuppt sich am Boden, auch in Gehäuse der Raupe.

12. *Epinotia (Evetria) pusillana* (Peyerimhoff, 1863)

P (vgl. Patočka et al., 1960) 4—5 × 1—1,5 mm (10 P) rötlichbraun, F grünlich, Exuvie blass gelbbraun. Stirn mit einem meist dreispitzigen Fortsatz. Ein Höckerpaar oft auch darüber und an der Basis der Zunge (Abb. 54). R. rel. lang, Zunge rd. 2 × länger als die Ul. Spitze der Vfl. scharfwinklig, aber ziemlich stumpf. Hbr. zu rd $\frac{2}{3}$ ausgeschnitten (Abb. 55), Leiste fehlt praktisch. D rel. stark, am Hlb 2 wenig schwächer als am Hlb 3, am Hlb 3—7 die der Bre deutlich grösser als die der Kre. Kre kammförmig. Am Hlb 4 zwischen den Rbt gibt es 4—5 D der Bre und 12—15 D der Kre. Laterale D am Hlb 10 vergrössert, die dorsalen D dort etwa so gross wie die am Hlb 8, 9 oder die der Bre am Hlb 4. Nur 1 Paar von Eh und keine Peh vorhanden. Kpe schwach gewölbt ohne deutliche Ventralkante (Abb. 56—58).

Raupe miniert und verspinnt die Tannennadeln vom Spätsommer zum Frühling, überwintert in ihrem Gehäuse und verpuppt sich in einem Kokon in der Waldstreu.

13. *Epinotia (Evetria) signatana* (Douglas, 1845)

P (10 P) rotbraun, Fl mehr grünlich, Exuvie heller. Stirn zwischen den F mässig erhaben. F. mittellang. Zunge kaum 2 × länger als die Ul. Spitze der

Vfl ziemlich stumpf (Abb. 59). Hbr rd. zu $\frac{1}{2}$ ausgeschnitten mit angedeuteten Leisten (Abb. 60). D am Hlb 2 breiter und kleiner als am Hlb 3. Sonst die D rel. gross und steil, die der Bre viel grösser als die der Kre. Am Hlb 4 zwischen den Rbt gibt es 5—6 D der Bre und 17—20 D der Kre. D am Hlb 9 und 10 fast gleichgross, etwas kleiner als die der Bre am Hlb 4, Seitendornen am Hlb 10 kaum vergrössert. 2 Paar von Eh und 1 Paar Peh rel. stark. Kpe mässig gewölbt, Ventralkante stark, mit oft zahnartigen Leisten und langsgerunzelter Ventralseite (Abb. 61—63).

Raupe hauptsächlich an *Padus*, verpuppt sich am Boden in einem Kokon.

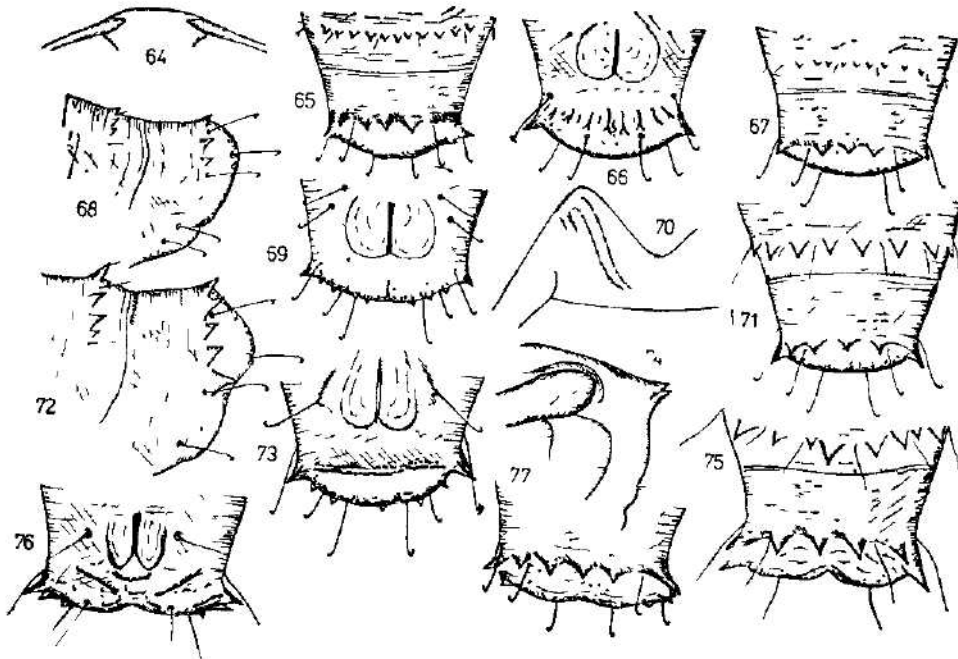


Abb. 64—66 *E abbreviana*: 64 — Stirn, 65 — Hlb 9—10 von oben, 66 — Hlb 10 von unten Abb 67—69 *E. cruciana*: 67 — Hlb 9—10 von oben, 68 — von der Seite, 69 — Hlb 10 von unten Abb 70—73 *E. stroemiana*: 70 — Hbr, 71 — Hlb 9—10 von oben, 72 — von der Seite, 73 — Hlb 10 von unten Abb 74—76 *E. sordidana*: 74 — Kopf von der Seite, 75 — Hlb 9—10 von oben, 76 — Hlb 10 von unten Abb. 77 *E. caprana*: Hlb 10 von oben

14. *Epinotia (Evetria) cruciana* (Linnaeus, 1761)

P 5—6,5 × 1,5—2 mm (10 P) rotbraun, Exuvie heller. Stirn zwischen den F rel. deutlich hervortretend, F rel. kurz. Zunge rd 2× länger als die Ul. Hbr kaum zu $\frac{1}{2}$ ausgeschnitten, Leisten schwach oder fehlend. D rel. klein, am Hlb 2 kleiner und breiter als am Hlb 3, D der Bre deutlich grösser als die der Kre. Am Hlb 4 gibt es 6—10 D der Bre und 16—20 D der Kre zwischen den Rbt. D am Hlb 10 grösser als die am Hlb 8 und 9, die lateralen nicht vergrössert. Am Hlb 10 gibt es 3 Paar von Eh und 2 Paar feine Peh. Kpe

gewölbt, ventral geschieft ohne Ventralkante, rauh, aber ohne Runzeln (Abb. 67—69).

Raupe in versponnenen Blättern von *Salix*-Arten, verpuppt sich in einem Kokon am Boden.

15. *Epinotia (Hamuligera) abbreviana* (Fabricius, 1798)

Syn *E. trimaculana* (Donovan, 1806)

P 5—6,5 × 1,5—2 mm (10 P), rötlich braun, Exuvie blass rotbraun. Stirn sehr schwach gewölbt (Abb. 64). Zunge meist kürzer als die doppelte Länge der Ul. F rel. lang. Spitze der Vfl breit. Hbr etwa zu $\frac{1}{2}$ ausgeschnitten mit angedeuteter Leiste. D schwach bis mittelstark, die der Kre deutlich kleiner als die der Bre, die ersteren ein bisschen kammartig. D am Hlb 2 kaum kleiner als am Hlb 3. Am Hlb 4 gibt es 4—6 D der Bre und 17—20 denen der Kre zwischen den Rbt. D am Hlb 9 etwas kleiner, die am Hlb 10 so gross oder etwas grösser als die der Bre am Hlb 4, die lateralen D am Hlb 10 kaum grösser als die dorsalen. Bt rel. deutlich, bleich. Hlb 10 mit 3 Paar von Eh und 1 Paar von Peh, diese recht schwach. Die lateralen Eh entspringen frontal von Seitendornen. Kpe mässig gewölbt, ventral gerunzelt, aber kaum kantenartig (Abb. 65, 66).

Die Raupe zwischen versponnenen Blättern an *Ulmus*. Verpuppung meist in einem Kokon am Boden.

16. *Epinotia (Epinotia) stroemiana* (Fabricius, 1781)

P 7—7,5 × 2—2,5 mm (1♂, 1♀), rotbraun, Exuvie heller, ♀ grösser und dunkler als das ♂. Stirn zwischen den F schwach erhaben, sonst abgerundet. F rel. kurz, Zunge kürzer als die doppelte Länge der Ul. Vfl spitzig. Hbr zu mehr als $\frac{1}{2}$ breit ausgeschnitten, Leistengebilde deutlich (Abb. 70). D rel stark, am Hlb 2 etwas kleiner als am Hlb 3, am Hlb 3—7 D der Bre mässig grösser und steiler als die der Kre. Am Hlb 4 gibt es 6—8 D der Bre und 15—18 denen der Kre zwischen den Rbt. D am Hlb 10 wenig grösser als die D am Hlb 8 und 9, die lateralen D nicht vergrössert. Bt rel. gross und deutlich. Hlb 10 mit 3 Paar von Eh und 1 Paar von Peh, ähnlich wie bei *E. abbreviana*. Kpe gewölbt, Ventralkante deutlich, dort die Kpe am höchsten (Abb. 71—73).

Die Raupe zwischen versponnenen Blättern der Birke, verpuppung daselbst oder am Boden.

17. *Epinotia (Epinotia) sordidana* (Hübner, 1823—1824)

P 9—11 × 2,5—3 mm (1♂ und 1♀) dunkel rötlich braun, Exuvie trüb rotbraun. Stirn mit starker Doppelspitze, über die Wurzel der F mässig erhaben (Abb. 74). Kopf und Thoraxrücken deutlich gerunzelt. F mittellang. Zunge rd. 2× länger als die Ul. Spitze der Vfl stark vorgezogen, Hbr tiefer als zu $\frac{1}{2}$ ausgeschnitten, ähnlich wie der Mbr mit deutlichen Leisten. D sehr stark, am Hlb 2 breiter und wenig kleiner als am Hlb 3. D der Kre breit, etwas kammförmig, deutlich kleiner als die der Bre. Am Hlb 4 gibt es 4—5 D der Bre und 13—15 D der Kre zwischen den Rbt. D am Hlb 10 kaum grösser als die am Hlb 8—9, laterale D nicht vergrössert. Bt stark. Eh (3 Paar) und Peh (1 Paar) mehr borstenförmig. Kpe wenig gewölbt, rauh, ventral mässig gerunzelt (Abb. 75—76).

Raupe in versponnenen Blättern von *Alnus*, verpuppung am Boden.

18. *Epinotia (Epinotia) caprana* (Fabricius, 1798)

P (10 P) etwa so gross und ähnlich gefärbt wie die vorige, Exuvie reiner rotbraun. Stirnfortsatz einfach, stumpf (Abb. 78). Kopf und Thorax schwächer gerunzelt. F rel. länger. D nur mittelgross, weniger steil, am Hlb 2 viel kleiner als am Hlb 3. Am Hlb 4 zwischen den Rbt gibt es 4—5 D der Bre und 13—15 D der Kre. D der Kre undeutlich kammartig. D am Hlb 10 etwas grösser als die am Hlb 9, laterale D nicht vergrössert. 3 Paar von Eh und 1 Paar Peh rel. klein, hakenförmig. Bt deutlich. Kpe ventral mehr gerunzelt als bei *E. sordidana* (Abb. 77, 79).

Die Raupe lebt an *Salix* (insbes. *S. aurita*, *cinerea*, *caprea*) zwischen versponnenen Blättern, Verpuppung in einem Kokon am Boden.

3. Gattung *Rhopobota* Lederer, 1859

Durch geringe Grösse, niedrige Zahl der D zwischen den Rbt und zahl der Eh (3 Paare) und Peh (2 Paare) charakterisiert.

1. *Rhopobota naevana* (Hübner, 1814—1817)

P (1♀) 5,8 × 1,2 mm, rötlich gelbbraun, Exuvie heller, ziemlich glänzend, rel. glatt. Stirn schwach, aber deutlich zwischen den F hervorstehend, Zunge rd. 2 × länger als die Ul, F rel. kurz. Spitze der Vfl stumpf (Abb. 80). Hbr über $\frac{1}{2}$ ausgeschnitten, ohne deutliche Leistengebilde. D rel. klein, am Hlb 1 fehlend, am Hlb 2 viel kleiner als am Hlb 3. Am Hlb 3—7 die D der Bre steiler und deutlich grösser als die der Kre, Am Hlb 4 gibt es 6 D der Bre und 11 D der Kre zwischen den Rbt. D am Hlb 10 viel grösser als die am Hlb 8 und 9, die lateralen D nicht vergrössert. Häkchen schlank. Gruppe VII am Hlb 4—6 drei-, am Hlb 7—9 zweiborstig. Kpe mässig gewölbt, rel. glatt, Ventralkante nicht entwickelt.

Raupe polyphag, an Obstbäumen zuweilen schädlich, verpuppt sich in ihrem Gehäuse oder am Boden.

4. Gattung *Zeiraphera* Treitschke, 1829

Mittelgrosse bis ziemlich grosse, rel. gedrungene, fein skulpturierte P, rotbraun gefärbt (Exuvie blasser), mässig glänzend. Stirn zwischen den Fühlwurzel schmal und deutlich erhaben, sonst abgerundet. F rel. lang. Zunge rd. 2 × länger als die Ul. Vfl spitzig Hbr zu $\frac{1}{2}$ oder etwas darüber ausgeschnitten mit ± angedeuteten Leistengebilden. D am Hlb 2 denen am Hlb 3 ziemlich ähnlich. D sehr stark und steil, die der Kre viel kleiner als die der Bre. D am Hlb 8 und 9 kaum kleiner als die der Bre am Hlb 4. D am Hlb 10 rel. zahlreich, etwas grösser als am Hlb 9, laterale D nicht vergrössert. Bt deutlich, VII am Hlb 4—6 drei-, am Hlb 7—9 zweiborstig. Mit 4 Paar von Eh und 1 Paar von Peh. Kpe meist rel. stark vorgewölbt, ventral gerunzelt. Die P der einzelnen Arten sind einander ähnlich.

Alle Arten überwintern als Ei, leben als Raupe zwischen versponnenen Nadeln oder Blättern junger Triebe und verpuppen sich im Boden in einem Erdkokon.

Bestimmungstabelle der Arten

1. Am Hlb 1 kleine D der Kre angedeutet (Abb. 84). Kpe stark zweilappig (Abb. 86). An Eichen *Z. isertana*

- Hlb 1 ohne D. Kpe schwach zweilappig oder einfach (Abb. 93). An Nadelhölzern
- 2(1) 7–10 × 2,5–3 mm, rel. dunkel rotbraun. D der Kre rel. breit (Abb. 90). Gebirgsart
Z. diniana
- 5–7 × 1,8–2,4 mm, heller rotbraun. D der Kre schmal (Abb. 92). Auch in tieferen Lagen
- 3(2) Am Hlb 4 zwischen den Rbt gibt es 15–18 D der Kre. Hbr mit rel. schwachen Leisten. An Tannen
Z. rufimitrana
- Am Hlb 4 zwischen den Rbt gibt es rd 12 D der Kre. Hbr mit rel. stärkeren Leisten. Hauptsächlich an Fichten, auch Kiefern
Z. ratzeburgiana

1. *Zeiraphera isertana* (Fabricius, 1794)

P 6–8 × 1,8–2,5 mm (10 P). Vfl rel. stumpf, Ol schwächer zusammenlaufend. Rücken gerunzelt. Hbr zu mehr als 1/2 ausgeschnitten, Leistengebilde stark (Abb. 85). Am Hlb 1 D der Kre entwickelt, bezw. angedeutet (Abb. 84), D sehr stark, am Hlb 4 zwischen den Rbt gibt es 5–6 D der Bre und 13–17 D der Kre. D am Hlb 10 meist noch stärker als am Hlb 9. Kpe stark zweilappig. Eh fein, manchmal ziemlich borstenförmig (Abb. 86, 87).

Raupe an Eichen, manchmal eine Mordraupe.

2. *Zeiraphera diniana* (Guenée, 1845)

P 7–10 × 2,5–3 mm (10 P), rel. dunkel rotbraun. Ol meist stärker zusammenlaufend (Abb. 89). Spitze der Vfl. oft schmaler. Hbr. mit rel. schwächeren Leisten. Am Hlb 1 fehlen die D. Die D der Kre rel. breit (Abb. 90). Am Hlb 4 zwischen den Rbt. gibt es 5–8 D der Bre und 11–15 D der Kre. Eh bleich, schwach, deutlich hakenförmig. Kpe schwach- oder nicht zweilappig, ventral schwächer gerunzelt (Abb. 88).

An Nadelhölzern im Gebirge. Schädlich an Lärchen und Arven (Alpen), an Fichten (Sudeten und Karpathen).

3. *Zeiraphera rufimitrana* (Herrich-Schäffer, 1851)

P 5–7 × 1,8–2,4 mm (10 P), heller rotbraun, Ol läuft stark zusammen. Spitze der Vfl rel. scharf. Leistengebilde am Hbr schwach, Hlb 1 ohne D. D rel. stark, die der Kre meist schlanker (Abb. 92). Am Hlb 4 gibt es 5–6 D der Bre und 15–18 D der Kre zwischen den Rbt. Eh fein und bleich. Kpe niemals zweilappig, Ventralseite ± gerunzelt (Abb. 91, 93).

Raupe an Tannen, manchmal ein Forstschädling.

4. *Zeiraphera ratzeburgiana* (Ratzeburg, 1840)

So gross wie *Z. rufimitrana* (1 ♂, 1 ♀), etwas bleicher, glatter, Ol deutlich zusammenlaufend. Thorax weniger gerunzelt, Hbr mit stärkeren Leisten. D fehlen am Hlb 2, die der Kre rel. schmal. Hlb 4 mit 5 D der Bre und 12 D der Kre zwischen den Rbt. Häkchen rel. dicker, die mittleren ventralen Eh sehr nahe beieinander. Kpe ähnlich wie bei *Z. rufimitrana*.

Raupe an Fichten und Kiefern, selten auch an Tannen.

5. Gattung *Gypsonoma* Meyrick, 1895

Kleinere, ziemlich gedrungene P, rotbraun, Exuvie blasser, mässig glänzend und skulpturiert. Stirn zwischen den F mässig vorgewölbt, abgerundet. F rel. kurz. Ol trapezförmig. Zunge meist kürzer als die doppelte Ul. Spitze der Vfl meistens stumpf (Abb. 96). D mittelgross und mittelsteil, am Hlb 1 fehlend, am Hlb 2

kaum kleiner als am Hlb 3, seltener deutlich kleiner. Am Hlb 3—7 D der Bre viel grösser als die der Kre. Am Hlb 4 gibt es 5—10 D der Bre und 20—30 D der Kre zwischen den Rbt. D am Hlb 8 und 9 meist kaum kleiner als die der Bre am Hlb 4, D am Hlb 10 kaum bis wenig grösser als diese. Die lateralen D nicht grösser als die dorsalen. Bt klein, unauffallend. VII am Hlb 4—6 drei- am Hlb 7—9 zweiborstig. Hähchen ziemlich stark, 3 paar von Eh und

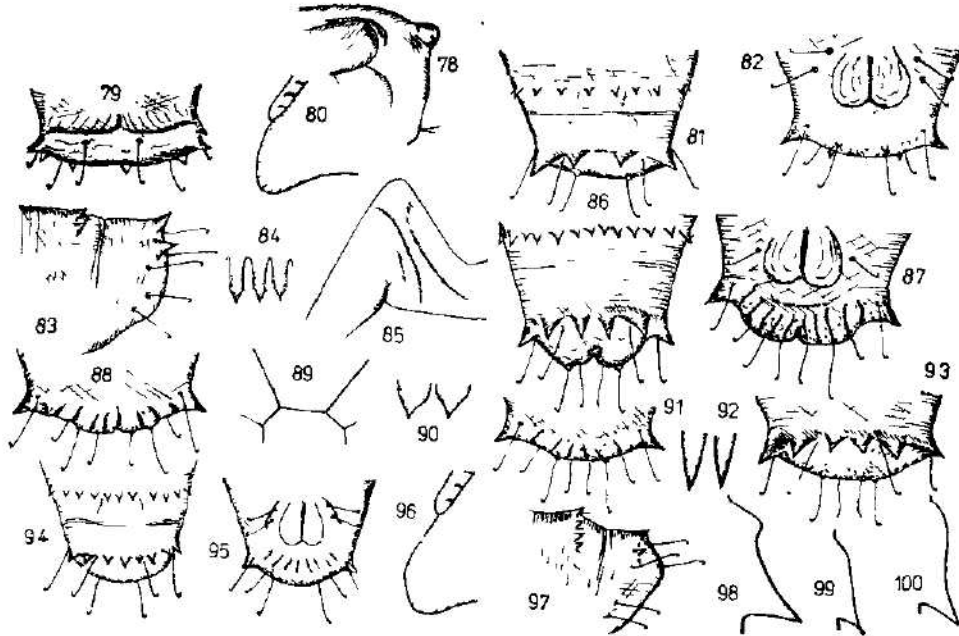


Abb. 78—79. *E. caprana*: 78 — Kopf von der Seite, 79 — Hlb von unten. Abb. 80—83 *Rhopobota naevana*: 80 — Spitze der Vfl, 81 — Hlb 9—10 von oben, 82 — Hlb 10 von unten, 83 — Hlb 9—10 von der Seite. Abb. 84—87. *Zeirephera isertana*: 84 — D der Kre am Hlb 1, 85 — Hbr, 86 — Hlb 9—10 von oben, 87 — Hlb 10 von unten. Abb. 88—90 *Z. dimana*: 88 — Hlb 10 von unten, 89—91, 90 — D der Kre am Hlb 3. Abb. 91—93. *Z. rufnitrana*: 91 — Hlb (Endteil) von unten, 92 — D der Kre am Hlb 3, 93 — Hlb 10 von oben. Abb. 94—97 *Gypsonoma opressana*: 94 — Hlb 9—10 von oben, 95 — Hlb 10 von unten, 96 — Spitze der Vfl, 97 — Hlb 9—10 von der Seite. Abb. 98—99. *Epiblema uddmannana*: 98 — D der Bre am Hlb 4, 99 — D der Kre am Hlb 4. Abb. 100. *E. trimaculana*: D der Bre am Hlb 4

2 Paar von Peh vorhanden. Kpe mässig gewölbt, ± skulpturiert ohne deutliche Ventralkante, ventral oft gerunzelt (Abb. 94, 95, 97).

Die Raupen vorwiegend an Salicaceae, insbes. an Pappeln. Es überwintert die Raupe, seltener die Puppe, verpuppung in einem Kokon am Boden.

Bei den untersuchten vier Arten: *G. sociana* (Haworth, 1811), *G. dealbana* (Froelich, 1828), *G. opressana* (Treitschke, 1835) und *G. minutana* (Hübner, 1796—1799), bei denen wenigstens je 10 P untersucht wurden, konnte ich keine stabilen Unterscheidungsmerkmale finden. Es fehlen noch: *G. aceriana* (Duponchel, 1843), *G. nitidulana* (Lienig et Zeller, 1846).

6. Gattung *Epiblema* Hübner, 1825

P rel gross, 8—11 × 1,8—2,6 mm, Stirn zwischen den F schmal, deutlich erhaben, ohne Fortsätze, Zunge rd 2× länger als die Ol, Spitze der Vfl rel. stumpf. Hbr über ½ breit ausgeschmitten, Leistengebilde rel. stark (Abb. 104). D am Hlb 1 fehlend, sonst mittelgross, die der Bre rel. steil, deutlich (am Hlb 2 weniger deutlich) grösser als die der Kre. Am Hlb 3—7 beide Reihen, insbes. die Kre deutlich kammartig mit feinen Rillen zwischen den D (Abb. 98—100) Dornreihe am Hlb 9 und —10 manchmal mehrfach. Bt rel. deutlich, Gruppe VII am Hlb 4—6 drei-, am Hlb 7—8 zwei- und am Hlb 9 einborstig. Mit 3 Paar von Eh und 2 Paar von Peh. Die lateralen Eh entspringen frontal von den lateralen D. Kpe mässig erhaben, ventral oft gerunzelt bzw. mit Leisten und Zahngebilden. Die dendrophilen Arten gehören in die Untergattung *Notocelia* Hübner, 1825. Sie sind einander ähnlich.

Die Raupen leben an Rosaceae, überwintern gewöhnlich, verpuppen sich meist im Gehäuse der Raupe zwischen den Endblättern eines Triebes.

Bestimmungstabelle der Arten (es fehlen noch: *E. rosaecolana* (Doubleday, 1850), *N. incarnatana* (Hübner, 1799—1800), *N. tetragonana* (Stephens, 1834)).

- | | | |
|------|--|------------------------|
| 1. | P rauchbraun. An <i>Crataegus</i> | <i>E. trimaculana</i> |
| — | P rotbraun bis gelbbraun | 2 |
| 2(1) | Am Hlb 10 die D deutlich grösser als am Hlb 9, dort die Dornreihe einfach (Abb. 105). Peh praktisch gleich gross (Abb. 102) Eh rel. kurz, oft bleich | 3 |
| — | Am Hlb 10 die D kaum grösser als am Hlb 9, dort die Reihe mehrfach (Abb. 108) Eh schlank, dunkel, Peh ungleich dick (Abb. 109) | <i>E. cynosbatella</i> |
| 3(2) | P mehr gelblich rotbraun Kpe mit starker, gezahnelten Ventralkante (vgl. Abb. 106). An <i>Rosa</i> | <i>E. roborana</i> |
| — | P dunkler rötlich braun Kpe mit schwacher, höchstens gerunzelten Ventralkante (Abb. 102) An <i>Rubus</i> | <i>E. uddmanniana</i> |

1. *Epiblema (Notocelia) uddmanniana* (Linnaeus, 1758)

P 9—11 mm lang (10 P) dunkel rötlich braun, Exuvie heller. D der Bre gross, auch basal höckerartig (Abb. 98). D am Hlb 9 in einfacher Reihe, die am Hlb 10 deutlich grösser. Hähchen kürzer, dick, die der Peh gleichdick (Abb. 101—103). Kpe mit schwacher Ventralkante, Ventralseite oft gerunzelt (Abb. 102).

Raupe an *Rubus*.

2. *Epiblema (Notocelia) trimaculana* (Haworth, 1811)

P meist nur 8—10 mm lang (10 P) rauchbraun, Exuvie heller. D der Bre ohne basale Höcker (Abb. 100). D am Hlb 10 oft teilweise mehrfach, die am Hlb 9 etwas kleiner, einfach, regelmässig. Eh meist ziemlich stark und rel. dunkel, die kaudalen Peh deutlich dünner als die frontalen. Kpe oft mit starker, mit Leisten und Zahnchen versehener Ventralkante (Abb. 105, 106).

Raupe an *Crataegus*.

3. *Epiblema (Notocelia) cynosbatella* (Linnaeus, 1758)

P (1 ♂, 2 ♀♀) so gross wie die vorige, dunkel rotbraun, Fl mehr grünlich, Exuvie rotbraun. D der Bre, insbes. am Hlb 1 mit basalen Höckern (Abb. 98). D am Hlb 9 teilweise mehrfach, die am Hlb 10 ungleich gross, kaum grösser als am Hlb 9. Eh lang, schlank, dunkel. Frontale Peh deutlich dicker als die

kaudalen. Kpe mit stark geleisteter und gezählter Ventralkante (Abb. 107—109).

Raupa an *Rosa*.

4. *Epiblema (Notocelia) roborana* (Denis et Schiffermüller, 1775)

P (10 P) so gross wie die vorigen, rötlich gelbbraun, Exuvie heller. D der Bre

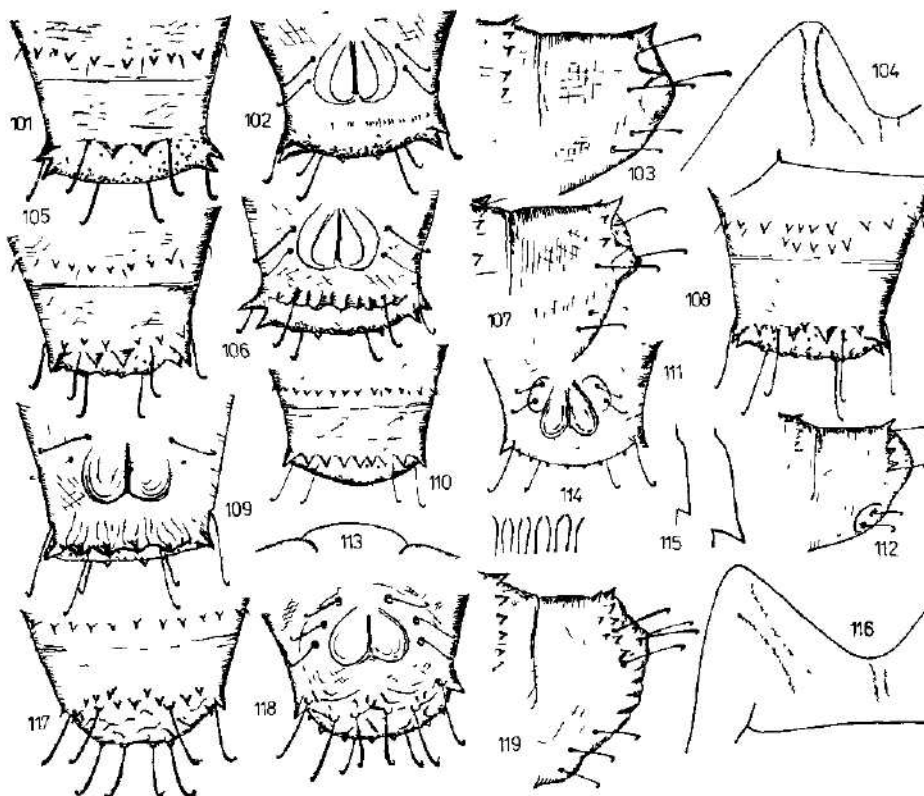


Abb. 101—103 *E. uddmanniana*: 101 — Hlb 9—10 von oben, 102 — Hlb 10 von unten, 103 — Hlb 9—10 von der Seite. Abb. 104—106 *E. trimaculana*: 104 — Hbr, 105 — Hlb 9—10 von oben, 106 — Hlb 10 von unten. Abb. 107—109 *E. cynosbatella*: 107 — Hlb 9—10 von der Seite, 108 — von oben, 109 — Hlb 10 von unten. Abb. 110—112 *Spilonota ocellana*: 110 — Hlb 9—10 von oben, 111 — Hlb 10 von unten, 112 — Hlb 9—10 von der Seite. Abb. 113—119 *Barbara herrichiana*: 113 — Stern, 114 — Leisten am Hlb 1, 115 — D der Bre und Kre am Hlb 3, 116 — Hbr, 117 — Hlb 9—10 von oben, 118 — Hlb 10 von unten, 119 — Hlb 9—10 von der Seite.

ohne Basalhöcker, die am Hlb 10 oft etwas grösser als am Hlb 9, an beiden nicht selten in mehrfacher Reihe. Häkchen bleich, rel. kurz und dick. Peh fast gleichgross. Kpe mit deutlicher Ventralkante mit Leisten und Zähnen.

Raupa an *Rosa*.

7. Gattung *Spilonota* Stephens, 1829

P mittelgross, Stirn zwischen den F breit und wenig hervorstehend, sonst abgerundet. D auffallend klein, nicht kammartig, die der Bre deutlich grösser als die der Kre, am Hlb 10 grösser als am Hlb 9. Mit 2 Paar Eh und 2 Paar Peh (Abb. 110, 111).

Die Raupen überwintern, leben zwischen versponnenen Blättern (jung in Knospen), verpuppen sich meist in ihrem Gehäuse.

1. *Spilonota ocellana* (Denis et Schiffermüller, 1775)

P 6,5—7,5 × 1,5—1,8 mm, rötlich braun, ziemlich glänzend und fein skulpturiert, Exuvie heller. Zunge kaum 2 × länger als die Ul. Hbr. mehr als zu $\frac{1}{2}$ breit ausgeschnitten, ohne deutliche Leistengebilde. Hlb 1 dornlos, am Hlb 2 die D der Bre und Kre fast gleichgross, kleiner als am Hlb 3. Am Hlb 4 gibt es 6—10 D der Bre und 20—35 denen der Kre zwischen den Rbt. Bt schwach, VII am Hlb 4—6 drei-, am Hlb 7—9 zweiborstig. Am Hlb 10 die lateralen D nicht grösser als die dorsalen. Hakchen bleich und schlank. Kpe deutlich gewölbt, ungerunzelt, ohne Ventralkante (Abb. 110—112).

Raupe polyphag an Laubhölzern, Schädling der Obstbäume.

Bei der f. *laricana* (Heinemann, 1863) ist die P oft mehr gelbbraun, die D am Hlb 2 denen am Hlb 3 ähnlich, also die der Bre deutlich grösser als die der Kre.

Raupe lebt hauptsächlich an *Larix*.

8. Gattung *Barbara* Heinrich, 1923

P rel. gross, Stirn schwach hervorstehend, breit, abgerundet. D wenig steil, stark kammartig. Hlb 7 mit drei Bt der Gruppe VII. Mit 4 Paar von Eh und 3 Paar von Peh.

Die Raupe lebt in Früchten, Puppe überwintert.

1. *Barbara herrichiana* Obratzsov, 1960

P rel. gross und dick, 9—11 × 3—4 mm (6 P), dunkel rotbraun, ziemlich glänzend. F. mittellang. Zunge rd 2 × länger als die Ul. Vbr längsgerillt. Spitze der Vfl breit, aber scharf. Hbr zu $\frac{2}{3}$ ausgeschnitten, Leistengebilde schwach (Abb. 116). Hlb 1 ohne D, aber mit feinen Längsleisten und Rillen dazwischen (Abb. 114). Am Hlb 2 die D ähnlich wie am Hlb 3, am Hlb 3—7 die D der Bre deutlich grösser als die der Kre. Am Hlb 4 gibt es 8—10 D der Bre und 17—22 D der Kre zwischen den Rbt. Am Hlb 10 die D kaum grösser als am Hlb 9, laterale D nicht vergrössert. Dornreihe am Hlb 10 oft teilweise mehrfach. Hakchen rel. stark, alle von dunklen Ringen entspringend. Kpe gewölbt, rauh skulpturiert (Abb. 117—119). Vgl. auch P a t o č k a et al., 1960.

Die Raupe lebt in Tannenzapfen.

9. Gattung *Blastesthia* Obratzsov, 1960

P mittelgross bis rel. gross, stark glänzend. Stirn zwischen den F sehr schwach hervorstehend, ohne Fortsatz. F rel. lang. Zunge rd 2 × länger als die Ul. Vfl rel. stumpf (Abb. 121) Vbr an jeder Seite mit einer tiefen Grube (vgl. Abb. 125). Hbr zu rd. $\frac{1}{2}$ ausgeschnitten, ohne deutliche Leistengebilde. Hlb 1 ohne D, diese sonst klein, Bre vorwiegend mehrfach (Abb. 138), ihre D nicht grösser als die der Kre, welche kammartig sind. D am Hlb 10 nicht

grösser als am Hlb 9, auch die lateralen D nicht vergrössert. Bt rel. klein. Gruppe VII am Hlb 4—6 drei-, am Hlb 7—8 zwei-, am Hlb 9 einborstig. Am Hlb 9 die Bt ebenso hakenartig wie die Haken am Hlb 10. Mit 2 Paar von Eh und 2 Paar von Peh, Kpe mässig gewölbt, ohne Ventralkante (Abb. 120, 122—124). Vgl. auch Schröder, 1966.

Die Raupen leben in Knospen von *Pinus*, überwintern erwachsen. Verpuppung im Innern der ausgefressenen Knospen.

1. *Blastesthia turionella* (Linnaeus, 1758)

P 8—9 × 1,8—2,5 mm (6 P). Kopf und Thorax schwarzbraun, Abdominalringe rauchbraun, Intersegmente schwärzlich, Exuvie rauchbraun. Kpe stärker, regelmässig gewölbt (Abb. 120, 122).

Die Raupe bevorzugt stärkere Knospen insbes. von *P. sylvestris* (auch von *P. mugo* und *P. nigra*). Manchmal schädlich.

2. *Blastesthia posticana* (Zetterstedt, 1840)

P (nach Schröder, 1966) der von *B. turionella* sehr ähnlich, nur deutlich kleiner.

Die Raupe bevorzugt schwächere Knospen, insbes. von Seitenzweigen. An *Pinus sylvestris*, *P. mugo*.

3. *Blastesthia mughiana* (Zeller, 1868)

P 6—7 × 1,5—2 mm (3 ♂♂), dunkler als bei *B. turionella*, Kpe wenig gewölbt, sogar etwas konkav (Abb. 123, 124). Sonst *B. turionella* sehr ähnlich.

Eine Hochgebirgsart, Raupe an *Pinus mugo* und *P. cembra*, überwintert zweimal.

10. Gattung *Petrova* Heinrich, 1923

P glänzend, Stirn schwach erhaben und mit einem stumpfen Fortsatz (Abb. 126). Vbr an jeder Seite mit einer Grube (Abb. 125). D ähnlich wie bei *Blastesthia*, nur etwas stärker. Intersegmente am Hlb mit Stachelchen besetzt. VII am Hlb 4—6 vierborstig (Abb. 138). Bt am Hlb 9 hakenartig (Abb. 127). Hlb 10 mit 2 Paar von Eh und 2 Paar von Peh (Abb. 129). Vgl. auch Schröder, 1966.

Die Raupe in Harzgallen an Zweigen von *Pinus*.

1. *Petrova resinella* (Linnaeus, 1758)

P 8,5—10,5 × 1,8—2,5 mm (6 P), Kopf und Thorax rauchbraun bis schwarzbraun, Abdomen trüb rotbraun, Exuvie heller. F rel. kurz. Zunge kaum 2 × länger als die Ul. Spitze der Vfl. winkelig (Abb. 118). Hbr kaum zu $\frac{1}{2}$ ausgeschnitten, Leistengebilde undeutlich (Abb. 130). Hlb 1 ohne D, aber mit ± angedeuteten Längsrillen, im Hinterteil rauh, D am Hlb 2 schwächer als am Hlb 3. D der Kre kaum kleiner als die der Bre, stark kammartig. Am Hlb 4 gibt es 30 oder mehr D der Kre zwischen den Rbt. D am Hlb 10 nicht grösser als die am Hlb 9. Kpe schwach gewölbt und fein skulpturiert.

Die Raupe hauptsächlich an *Pinus sylvestris*, überwintert zweimal.

11. Gattung *Rhyacionia* Hubner, 1825

Stirn mit einem Fortsatz (Abb. 131, 135, 136). Vbr ohne Grube. Intersegmente ohne Dörnchen, mit Zellskulptur, Dornreihen einfach. Laterale D am Hlb 10

nicht vergrößert. Bt deutlich. Am Hlb 4–6 die Bt IVa hinter dem Luftloch vorhanden. VII am Hlb 4–6 drei-, am Hlb 7–9 zweiborstig. Bt am Hlb 9 borstenförmig. Mit 2 Paar von Eh und 4 Paar von Peh, alle hakenförmig (Abb. 140, 141). Vgl. auch Schröder, 1966.

Die Raupen in Knospen und Trieben von *Pinus* (manchmal jung in Nadelbasen), Überwinterung als junge Raupe oder Puppe, Verpuppung an der Frasstelle, manchmal auch am Boden.

Bestimmungstabelle der Arten (nach Schroder, 1966, umgeändert)

- | | | |
|------|--|----------------------|
| 1 | Stirnfortsatz quer kieflförmig (Abb. 135), manchmal zweispitzig. P rot hell braun | <i>R. duplana</i> |
| | – Stirnfortsatz am Ende einspitzig – kegelförmig, scharf (Abb. 136, 137) oder stumpf (Abb. 131). P oft dunkler rotlich braun | 2 |
| 2(1) | Am Hlb 2–8 vor der Bre der D gibt es eine deutliche Querrinne | <i>R. pinicolana</i> |
| | – Am Hlb 2–8 keine deutliche Querrinne | 3 |

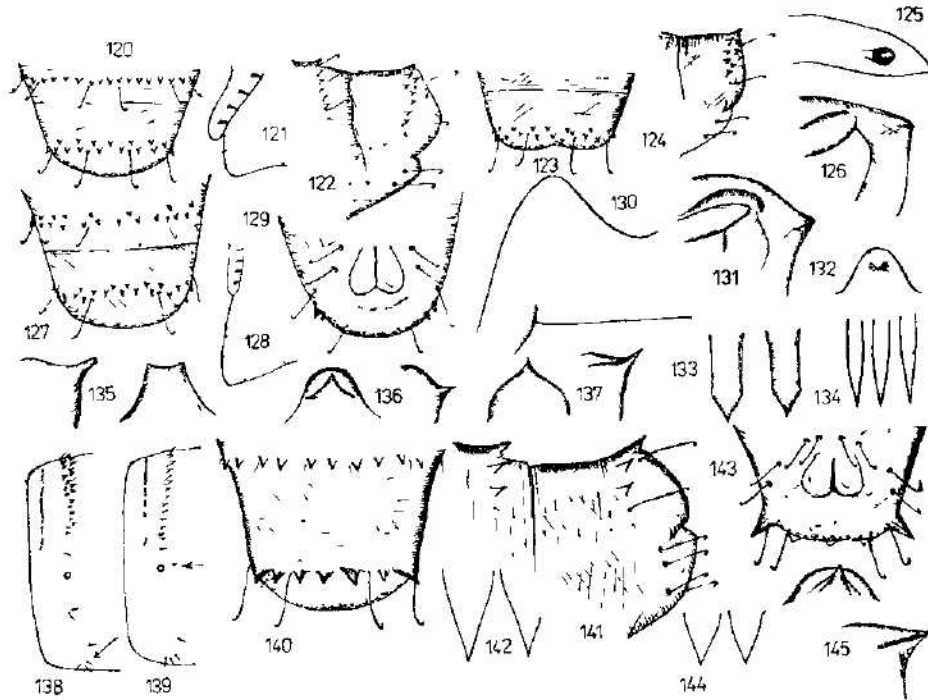


Abb. 120–122. *Blastesthia turionella*: 120 – Hlb 9–10 von oben, 121 – Spitze der VfI, 122 Hlb 9–10 von der Seite. Abb. 123–124. *B. mughiana*: 123 – Hlb 10 von oben, 124 – von der Seite. Abb. 125–129. *Petrova resinella*: 125 – Vbr (linke Seite), 126 – Kopf von der Seite, 127 – Hlb 9–10 von oben, 128 – Spitze der VfI, 129 – Hlb 10 von unten. Abb. 130–134. *Rhyacionia buoliana*: 130 – Hbr, 131 – Kopf von der Seite, 132 – Stirnfortsatz von vorne, 133 – D der Bre am Hlb 4, 134 – D der Kre am Hlb 4. Abb. 135. *R. duplana*: Stirnfortsatz (nach Schroder, umgeändert). Abb. 136. *R. pinicolana*: Stirnfortsatz (nach Schroder, umgeändert). Abb. 137. *R. pinivorana*: Stirnfortsatz (nach Schroder, umgeändert). Abb. 138. *Petrova resinella*: Hlb 6 von der Seite. Abb. 139–141. *Rhyacionia buoliana*: 139 – Hlb 6 von der Seite, 140 – Hlb 9–10 von oben, 141 – von der Seite. Abb. 142. *R. pinivorana*: D der Bre (nach Schroder, umgeändert). Abb. 143–145. *Clavigesta sylvestrana* (nach Schroder, umgeändert): 143 – Hlb 10, 144 – D der Bre, 145 – Stirnfortsatz.

- 3(2) D der Bre breit, erst am Ende zugespitzt (Abb. 133) Stirnfortsatz rel. stumpf (Abb. 131) *R. buoliana*
 — D der Bre kegelförmig (Abb. 142), Stirnfortsatz am Ende spitzig (Abb. 137) *R. pinivorana*

1. *Rhyacionia buoliana* (Denis et Schiffermüller, 1775)

P 8—11 × 2—3 mm (10 P), rothbraun, Bauch heller, Kopf und Thorax oft dunkler. Exuvie rötlich gelbbraun. Stirn zwischen den F stark komprimiert, erhaben, Fortsatz rel. stumpf (Abb. 131, 132), etwas quer. F. rel. lang. Spitze der Vfl schlank, aber ziemlich stumpf. Hbr zu rd. $\frac{1}{2}$ breit ausgeschnitten. Hlb 1 dornlos, an Stelle der Kre oft mit Leisten und Rillen dazwischen. Hlb 2—7 mit 2 Dornreihen, die beiden, insbes. Kre kammartig, dicht. D der Bre erst kurz vor dem Ende zugespitzt (Abb. 133), die der Kre schlanker (Abb. 134). Am Hlb 4 gibt es 7—10 D der Bre und 20—25 D der Kre zwischen den Rbt. D der Bre nur wenig grösser als die der Kre, D am Hlb 10 meist grösser als die am Hlb 8 und 9, steil. Häkchen rel. stark. Kpe gewölbt, mittelstark skulpturiert, Analregion gross (Abb. 140, 141).

Die Raupe lebt anfangs in Basen der Nadeln, dann in Knospen, nach der Überwinterung auch in Trieben, wo sie sich auch verpuppt. Ein Schädling junger Kiefern.

2. *Rhyacionia pinicolana* (Doubleday, 1849)

P (nach Schröder, 1966) etwa so gross und gefärbt wie die vorige, unterscheidet sich insbesondere durch den spitzigen Stirnfortsatz (Abb. 136), grössere, spitzig kegelförmige D der Bre (vgl. Abb. 124) — am Hlb 4 gibt es nur 5—6 D der Bre zwischen den Rbt — und tiefe Querrinne am Hlb 2—8 vor der Bre der D. Auch ist der Kopf, Mbr und Fl heller, Stirn dagegen dunkler gefärbt.

Bionomie vielleicht ähnlich der vorigen Art.

3. *Rhyacionia pinivorana* (Lienig et Zeller, 1946)

P (nach Schröder, 1966) so gross, bzw. wenig kleiner als die vorigen, rel. dunkler und reiner braun. Frontalspitze spitzig kegelförmig, schräg nach oben gerichtet (Abb. 137). D der Bre rel. kleiner (am Hlb 4 gibt es rd 10 D der Bre zwischen den Rbt) als bei *R. pinicolana*, ebenfalls spitzig kegelförmig (Abb. 142), davor jedoch keine Rinne.

Die Raupe lebt, ähnlich wie die vorigen, hauptsächlich an Seitentrieben von *P. sylvestris*, Verpuppung meist am Frassort.

4. *Rhyacionia duplana* (Hübner, 1811—1813)

P (nach Schröder, 1966) etwa so gross wie die vorige, aber deutlich heller braun. Kopf und Prothorax dunkler, Bauch braungelb, Exuvie bleich braungelb. Stirnfortsatz dorsoventral abgeflacht, quer kielförmig (Abb. 135), manchmal zweispitzig, schräg nach oben gerichtet. D der Bre basal breit, im Endteil stärker zugespitzt, am Hlb 4 zwischen den Rbt gibt es rd 6—8 D der Bre. Vor der Bre gibt es keine Querrinne.

Die Raupe lebt gruppenweise im Endteil der Kieferntriebe, verpuppt sich oft in der Waldstreu, die Puppe überwintert. Zuweilen schädlich.

12. Gattung *Clavigesta* Obraztsov, 1946

P kleiner als bei der vorigen Gattung, sonst ähnlich, Stirnfortsatz spitzig, Laterale D am Hlb 10 deutlich grösser als die dorsalen.

Die Raupe hauptsächlich an *Pinus*-Arten, überwintert, verpuppt sich an oder nahe der Frasstelle.

1. *Clavigesta sylvestrana* (Curtis, 1850)

P etwa $6-7 \times 1,5-2$ mm, braun, Exuvie gelbbraun, Abdomen ventral etwas heller. Stirnfortsatz spitzig kegelförmig, nur mässig schräg nach oben gerichtet (Abb. 145). D der Bre spitzig kegelförmig (Abb. 144), die der Kre schmalere und feiner. Dornreihe am Hlb 10 einfach, aus rd 5 D bestehend. Die lateralen D deutlich grösser als die dorsalen. Die 2 Paar von Eh und 4 Paar von Peh rel. stark (Abb. 143). Die Beschreibung der P vorwiegend nach Schröder, 1966.

Die Raupe an *Pinus* (angeblich auch an *Abies* und *Picea*) in Knospen, Blüten und jungen Trieben, Verpuppung an der Frasstelle oder in deren Nähe in einem Gespinst (Bradley et al., 1979).

DISCUSSION

Die Untersuchungen an den Puppen der Wickler aus der Tribus Eucosmini haben bewiesen, dass alle untersuchten Gattungen und die meisten dendrophilen Arten auf Grund der Puppenmerkmale gut zu charakterisieren sind. Die Ausnahmen bei der grossen Gattung *Epinotia* wurden bereits dort besprochen. Auch die Reihenfolge der Gattungen in der Auffassung von Bradley et al. (1979) kann man durch die Puppenmorphologie bestätigen.

Der Grundbauplan der Puppen dieser Gruppe entspricht dem, dass es sich meistens um Arten handelt, die zwar vorwiegend als Raupen zwischen versponnenen Blättern der Pflanzen leben, aber den Verpuppungsort am Boden in einem Erdkokon suchen. Dementsprechend kommt es zur Reduktion des Kremasters und der Hähkchen, welche bei manchen *Epinotia* — Arten (z. B. *E. tedella*, *E. pusillana*) gipfelt. In der Nachbarschaft der Tribus Olethreutini bleiben Gruppen und Arten (*Ancylis*, *Epinotia festivana*), die sich zwischen Blättern verpuppen. Bei diesen wird die volle Zahl der Endhähkchen und \pm auch der Kremaster erhalten. In der Nähe der Tribus Grapholitini befinden sich dagegen vorwiegend endophage Arten, die sich meist im Innern der Nährpflanzen auch verpuppen. Mit dieser Verpuppungsart sind morphologische Merkmale, die bereits bei der Tribus Grapholitini besprochen wurden (Patočka, 1982) — wie Stirnfortsätze, Abrundung des Oberteiles der Stirn, mehrfache und kammartige Dornreihen — in Verbindung. In einem knappen Verpuppungsraum würde ein Kremaster hindern und wäre unfunktionell, deshalb bildet er sich nicht aus, die Dornen werden zahlreicher, dichter und niedriger, die Stirnspitze findet beim Schlüpfen und Durchbrechen des Gespinstdeckels am Gangende ihre Berechtigung. Eine Stütze im leichten Kokon ist trotzdem nötig, deshalb werden die Hähkchen, insbes. die Perianalhähkchen vermehrt, bzw. vergrössert und auch die Borsten am 9. Hinterleibsring bilden sich manchmal (*Blastesthia*, Petrova) hakenartig aus um die Stützfläche zu vermehren.

Die Puppenmorphologie beweist offensichtlich die Berechtigung des modernen Systems der Tortricidae, weist jedoch auch auf einige dessen Mängel, z. B. im Falle von *E. festivana*, hin.

ZUSAMMENFASSUNG

Die vorliegende Arbeit bringt* Diagnose der Puppen der Tortricidae (Lepidoptera) aus der Tribus Eucosmini sowie Bestimmungstabellen und Diagnosen

deren dendrophilen Gattungen und Arten auf Grund der Puppenmerkmale. Es werden Einflüsse des Verpuppungsortes und Kokonbaues auf die Puppenmorphologie und -Taxonomie besprochen und das moderne System dieser Gruppe vom Gesichtspunkte der Puppenmorphologie diskutiert. Im allgemeinen wird seine Berechtigung bewiesen, auf einige Ausnahmen z. B. im Falle der *E. festivana* wird aufmerksam gemacht.

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**ANTIGONADOTROPIC EFFECT OF PRECOCENE II IN THE DYSDERCUS
CINGULATUS FEMALES (HETEROPTERA) WITH DENERVATED CORPUS
ALLATUM**

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Abstract. In adult females of *Dysdercus cingulatus* precocene II (P II) suppresses both ovarian development and food intake (measured by weight increase). Application of juvenile hormone analogue (JHa) stimulates ovarian development in P II-treated females most probably by compensation for the inactive CA. However, a considerably reduced number of oviposited eggs suggests that JHa cannot compensate for the antifeedant effect of P II. The nervous connection between brain and CA is not necessary for the inhibitory effect of P II.

INTRODUCTION

Bowers et al. (1976) discovered that chromene derivatives isolated from *Ageratum* plants and named precocene I (P I) and precocene II (P II) can induce precocious metamorphosis and prevent ovarian development in the adult females of some hemimetabolous and holometabolous insects (e. g. *Oncopeltus fasciatus*, *Dysdercus cingulatus*, *Lygaeus kalmii*, *Rhagoletis pomonella* and *Epilachna varivestis*). Antigonadotropic effect of P II can be reversed by the exogenous application of juvenile hormone analogue (JHa). It has been suggested that prevention of reproductive processes in the adult females by P II may be due to the inhibition of secretory function of corpus allatum (CA) (Unnithan et al., 1977, Bowers and Martinez-Pardo, 1977). Submicroscopical changes and degeneration of CA were observed in treated *O. fasciatus* (Unnithan et al., 1977) and *Locusta migratoria* (Pener et al., 1979). The experiments in vitro indicated that P II inhibits the CA directly (Pratt and Bowers, 1977, Müller et al., 1979, Pratt et al., 1980).

However, in many hemipteran species, it is quite usual that the inhibition of the CA in vivo by various intrinsic and extrinsic factors such as the lack of mating (Friedel, 1974 — *Dyndimus versicolor*; Mundall and Engelmann, 1977 — *Triatoma protracta*), starvation (Johansson, 1958 — *O. fasciatus*; Hodková and Socha, 1982 — *D. cingulatus*), and photoperiod (Hodková, 1975, 1976 — *Pyrrhocoris apterus*) is mediated by the nerves between the brain and CA. The inhibitory effects of these factors can be removed by denervation of the CA. We have investigated whether the same operation can remove the inhibitory effect of P II on the CA of *D. cingulatus* in vivo. The results were presented at a poster session of the 2nd Int. Conf. on Regulation of Insect Reproduction at Žinkovy, Czechoslovakia, and reported by King (Socha and Hodková, 1978). Similar results were obtained by Bowers and Aldrich (1980) in *O. fasciatus*.

Table I. Inhibition of reproduction by P II in females of *D. cingulatus*

| Treatment | n | Ovipos. females (%) | Eggs/female in the 1st batch | Pre-ovipos. period (days) |
|----------------------|----|---------------------|------------------------------|---------------------------|
| Unoperated + P II | 11 | 0 | — | — |
| Unoperated | 17 | 94.1 | 89.1 (57—120) | 9.0 (6—13) |
| Sham-operated + P II | 6 | 0 | — | — |
| Sham-operated | 9 | 88.9 | 85.5 (71—98) | 13.3 (8—20) |
| NA transected + P II | 10 | 0 | — | — |
| NA transected | 17 | 88.2 | 66.0 (36—101) | 9.5 (7—16) |

P-II applied within several hours after operation

MATERIAL AND METHODS

Individuals of *D. cingulatus* were reared on linden-seed at $26 \pm 1^\circ\text{C}$ and in long-day (18:6 h of light : darkness) conditions. The females destined for surgical manipulations were deprived of food within several hours after imaginal ecdysis and operated upon the next day. Surgical interventions were performed through an incision of the neck membrane under insect saline. Allatectomy was performed by excision of CA together with a piece of aorta. Denervation of CA was performed by transection of the nervi allati (NA) together with aorta. Only aorta was transected in the sham-operated females. The groups of females were kept for one week after operation in Petri dishes ($\varnothing = 9$ cm). In the treated groups the dishes were coated with $600 \mu\text{g}$ of P II. The treated as well as untreated females were isolated and paired with males one week after application of P II and/or operation. In the groups treated with JHa, the methyl 3,7,11-trimethyl-11-chloro-2-dodecenoate was dissolved in a mixture of acetone and olive oil (3:1) and applied topically in quantity of $10 \mu\text{g}$ in $1 \mu\text{l}$ to each individual.

The experiments were evaluated according to the reproductive activity of females; % of the ovipositing females, number of eggs in the first batch, and the pre-oviposition period were recorded. The non-ovipositing females were followed until death. Those non-ovipositing females that died sooner than the average pre-oviposition period were excluded from the experiment.

Table 2. Reactivation of P II-treated females of *D. cingulatus* by JHa

| Operation | n | Ovipos. females (%) | Eggs/female in the 1st batch | Pre-ovipos. ³⁾ period (days) |
|-----------------------------|---|---------------------|------------------------------|---|
| Unoperated ¹⁾ | 6 | 100 | 64.3 (53—82) | 4.1 (4—5) |
| NA transected ²⁾ | 9 | 88.9 | 31.9 (8—14) | 5.0 (5) |

¹⁾ P II applied to females within several hours after imaginal ecdysis. JHa applied 14—21 days after application of P II.

²⁾ P II applied within several hours after operation. JHa applied 7 days after application of P II.

³⁾ Pre-ovipos. period counted from the day of application of JHa.

RESULTS

Inhibition of reproduction by P II in females with denervated CA

Reproductive parameters in the females with transected NA (NA-females) were similar to controls (sham-operated and intact), showing high reproductive activity (Table 1). Thus the denervation of CA does not impair reproduction. On the other hand, oviposition was inhibited in all females treated with P II

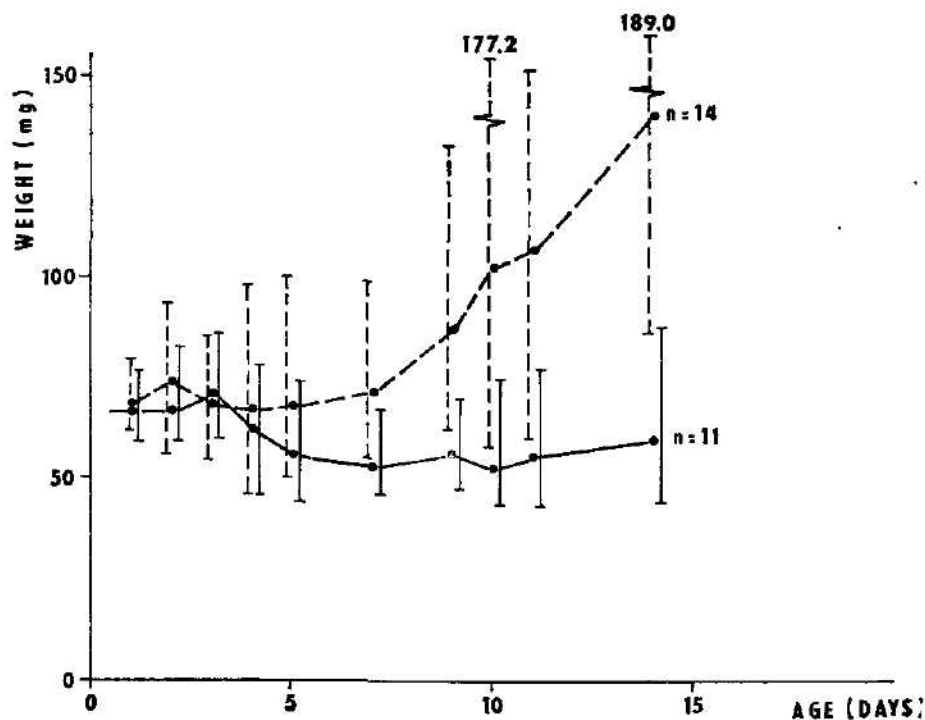


Fig. 1. Weight changes in untreated and P II-treated females of *D. cingulatus*. P II applied within several hours after imaginal ecdysis. Dotted line — untreated females, full line — P II-treated females. Bars represent max. and min. weight. From the day 10 to 14 females were weighted together with the oviposited eggs.

irrespective of whether their CA was denervated (Table 1). This demonstrates that a) P II inhibits reproduction, and b) the nervous connections between brain and CA are not necessary for the inhibitory effect.

Reactivation of the P II-treated females and the starved females by juvenile hormone analogue

Following experiments investigated whether the inhibition of reproduction by P II can be attributed to the inactivity of CA. The necessity of an active CA for reproduction was shown by allatectomy. The extirpation of CA inhibited oviposition during one-month experiment in 10 of the 11 operated females.

Table 3. Reactivation of starved females of *D. cingulatus* by JHa

| Treatment | n | Ovipos. females (%) | Eggs/female in the 1st batch | Pre-ovipos. period (days) |
|-----------|----|---------------------|------------------------------|---------------------------|
| Untreated | 13 | 0 | — | — |
| JHa | 7 | 100 | 32.0 (17—41) | 6.0 (6) |

JHa applied to females within several hours after imaginal ecdysis. Females were isolated and paired with males on the same day.

One female oviposited after 10 days most probably due to an incomplete extirpation of the gland.

If the inhibitory effect of P II is mediated by the suppression of the secretory activity of CA, the reproduction should be restored by application of JHa. Indeed, most of the NA⁻females treated with JHa 7 days after application of P II oviposited (Table 2). However, the number of oviposited eggs was two times lower than in the NA⁻females treated with neither P II nor JHa (Table 1). It appears, therefore, that a) P II inhibits the CA function, and b) the inhibition of CA is not the only effect of P II.

The females treated with P II failed to increase in weight, in contrast to the untreated females showing two-times weight increase during two weeks (Figure). Moreover, the NA⁻females treated with JHa 7 days after application of P II oviposited similarly reduced number of eggs as the starved females induced to oviposit by JHa (Table 2, 3). This indicates that P II suppresses the feeding activity or food utilization in addition to the inhibitory effect on the CA function. While an inactive CA in both P II-treated and the starved females can be replaced by JHa, this substance cannot compensate for the inhibitory effect of P II on the food intake.

When JHa was applied 14—21 days after treatment of the females with P II, the number of oviposited eggs was only third lower (Table 2) than in the untreated females (Table 1), most probably due to an accumulation of some nutritive reserves before the application of JHa. This suggests that feeding activity of the P II-treated females is at least partially renewed after some time, although the CA remains inhibited.

DISCUSSION

We have confirmed the results of Bowers et al. (1976) that P II prevents oviposition in *D. cingulatus*. The results showing that the ovarian development is resumed after the application of JHa to the P II-treated females of *D. cingulatus* agrees with the similar observations of Bowers et al. (1976) in *O. fasciatus* and Landers and Happ (1980) in *Drosophila melanogaster*.

It has been proved that in *D. cingulatus* the inhibitory effect of P II on the CA is not mediated by its nervous connections with the brain in contrast to the inhibitory effects of various intrinsic and extrinsic factors in various hemipteran species (for references see Introduction). It is still possible that P II affects the secretion of excitatory and/or inhibitory neurohormones that reach the CA by the hemolymph; there is general agreement that the brain controls

the function of CA through both nervous and humoral pathways (Hodková, 1976, De Kort and Granger, 1981). Unnithan et al. (1978) reported that in *O. fasciatus* the synthetic activity of median neurosecretory cells of the brain is inhibited by P II. The authors suggest, however, that the inactivity of these cells is rather a consequence than a cause of the CA degeneration as the neurosecretory cells can be reactivated by JHa-treatment.

An inhibition of the neurosecretory cells involved in regulation of the trophic functions (Thomsen, 1952, Sláma, 1964, 1971, Engelmann, 1970) might be responsible for suppression of the food intake observed in *D. cingulatus* (present paper) and several other species (Bowers et al., 1976, Sláma, 1978) after P II-treatment. However, at least in *D. cingulatus*, the suppression of feeding is not a consequence of the CA inactivation by P II as the application of JHa cannot compensate for the lack of nutritive reserves indicated by much reduced number of the oviposited eggs. Sláma (1978) suggests that the anti-feedant property of precocenes is rather a cause of their interference with the activation of endocrine glands. Indeed, in many species the food intake is necessary for stimulation of the activity of both CA (Engelmann, 1970) and median neurosecretory cells of the brain (Friedel and Loughton, 1980). However, the transection of NA in *D. cingulatus* reactivates the CA of the starved females (Hodková and Socha, 1982), while the same operation has not prevented the inhibitory effect of P II. Thus it seems that at least the inhibition of the denervated CA is not mediated by the antifeedant effect of P II either directly, by causing the lack of nutritive reserves in hemolymph, or through the neurosecretory cells dependent on feeding stimuli. Hence, it is probable that the direct inhibition of CA by P II, observed in the experiments in vitro (Pratt and Bowers, 1977, Müller et al., 1979, Pratt et al., 1980) is produced also in vivo.

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**A COMPARISON OF THE DIVERSITY OF CARABID BEETLES (COL., CARABIDAE)
OF TWO FLOODPLAIN FORESTS DIFFERENTLY AFFECTED BY EMISSIONS**

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Abstract: Comparable values of relative abundance were used for the calculation of diversity and the differences between the investigated plots were tested. There was a marked difference in diversity between subassociations of two floodplain forests; effects of noxious emissions on one of the plots have not been proved.

INTRODUCTION

It appears that the distribution of abundance, briefly and clearly summarized by means of indices of diversity, may be a more sensitive indicator of a recent environmental disturbance than the number of species. Thus a study of a stable environment which was ploughed and allowed to revert (Kemp-ton and Taylor 1974, Taylor, French and Woiwod 1978) showed that while after 3 or 4 years the number of species and individuals had returned to roughly the level achieved before disturbance, the distribution of abundances remained much more uneven, with an excess of both abundant and rare species and a dearth of species with medium abundance.

Furthermore, the diversity measure is more characteristic of the community at a site than is the number of species caught (Taylor, Kemp-ton and Woiwod 1976). May (1976) emphasized that the world may appear chaotic and vagarious at the level of individual species, nonetheless it may be constant and predictable at the level of community organization. Taylor (1978), sampling moths over several years at some 200 sites widely dispersed throughout Great Britain, has shown that major changes in species composition occur from year to year even at relatively stable sites. However, while the spatial distribution of individual moth species over the Island fluctuates erratically from year to year the compound measure of diversity for the communities of species has a stable spatial distribution.

Biotic components living at the border between the soil and aerial environments in the ecological systems of two floodplain forests differently affected by emissions are compared by means of the indices of diversity. The family of carabid beetles (Col., Carabidae) has been chosen as a model group because (1) it is one of the important ecological factors of the epigeon, (2) many species are closely attached to their environment and are very sensitive to its changes, and (3) material can be obtained by simple standard methods (Martiš 1979).

MATERIAL AND METHODS

Description of investigated areas and methods
of research

Two state nature reserves in Central Bohemia were chosen for research, Černí-novsko (about 80 hectares) in Mělník District, and Libický luh (about 370 ha) at

the border of two districts, Nymburk and Kolín. Observations in both reserves were made in climax subassociations of oak-elm woods, *Quercus-Ulmetum alnetosum* and *Quercus-Ulmetum carpinetosum*. The reserve Černínovsko is situated in the immediate vicinity of a chemical factory Spolana. The area is seriously polluted with carbon disulphide and hydrogen sulphide as well as wind-borne dust. Damage to plants by sulphur dioxide was ascertained in the reserve, some species of plants and herbivorous insects had been disappearing (Pecina & Pivničková 1975). There is no dangerous source of pollution near the reserve Libický luh.

A standard method of pitfall trapping was employed for collecting (e. g. Novák et al. 1969). One litre preserve jars 13 cm deep, upper diameter 8.6 cm, the opening a little narrowed to prevent trapped insects from escaping (Petruška 1969), protected by a glass roof, were used as traps; 4% solution of formaldehyde was used for conservation. The traps were placed at distances long enough to prevent excessive collecting (A dis 1979). They were laid on 2 April 1980 and their contents were collected at monthly intervals until 9 November 1980, more or less throughout the active period of the investigated species.

Thirteen pitfall traps were laid in each subassociation. According to Obrtel (1971) there is no statistically significant difference in average samples from 12 and 25 traps of this kind in a lowland forest. However, the total number of species cannot be ascertained by means of pitfall traps; a higher number of traps only results in an increase in the number of species occurring irregularly or accidentally. Because there is a linear relation between the average population density of carabid beetles and the number of those captured in pitfall traps throughout the active period of the investigated species (Baars 1979), seasonal catches from individual traps can be used as samples of abundance. According to Baars (1979), the linear relation between the immediate density and abundance shows a relative abundance enabling intraspecific comparisons of plots and years.

Evaluation of results

For the comparison of plots of different sizes and abundance, the index of diversity must be independent of the size of samples. An index of diversity formulated by Pielou (1966a) meets this condition. Pielou's method is to arrange sample data in random order and calculate how much (per individual) the total diversity is enhanced by individuals in each new sample, adding on the sample one. Successive calculations give independent estimates of H' , the true average diversity per individual, so that a standard error can also be calculated. Total species diversity is defined by the Brillouin (1956) measure appropriate to a finite collection, namely:

$$NH = \log_2 N! - \sum_{i=1}^s \log_2 n_i!,$$

where N is the total of individuals, n_i are the individuals of each species, and H is the mean diversity per individual in the collection itself. Samples are accumulated until H reaches a fairly stable level; then successive estimates of H' are begun. In this case, diversity H remained more or less the same for two and more pitfall traps. Although the successive values of H are not independent, we assume that successive increments (per individual) in NH are independent. Pielou (1966a) points out that "this is equivalent to assuming that in removing samples one by one from the whole collection of samples combined, we may treat the sampling as though it were done with replacement although it is done without. The assumption may safely be made provided a test shows no significant serial correlation between successive values of h_k ." Here h_k are the successive estimates whose average is the estimate of H' :

$$h_k = \frac{(N_k H_k - N_{k-1} H_{k-1})}{(N_k - N_{k-1})}$$

where the subscripts refer to the number of samples accumulated thus far in the process. Then H' may be estimated by

$$\tilde{H}' = \bar{h} = \frac{1}{n-t} \sum_{k=t+1}^n h_k,$$

and

$$\tilde{\text{var}}(\tilde{H}') = \tilde{\text{var}}(h) = \frac{1}{n(n-1)} (\sum h_i^2 - nh^{-2}),$$

Table 1. Survey of species and individual carabid beetles (Col., Carabidae) in Querc-Ulmetum alnetosum and Querc-Ulmetum carpinetosum subassociations of ak-elm woods in the nature reserves Černínovsko and Libický luh

| Species | Černínovsko | | Libický luh | |
|---|-------------|-------------|-------------|-------------|
| | Q. U. aln. | Q. U. carp. | Q. U. aln. | Q. U. carp. |
| <i>Abax carinatus</i> (Duft.) | 18 | 208 | 2 | 47 |
| <i>Abax parallelepipedus</i> (Pill. et Mitt.) | — | — | 78 | 165 |
| <i>Abax parallelus</i> (Duft.) | — | — | 14 | 246 |
| <i>Agonum assimile</i> (Payk.) | — | — | 167 | 58 |
| <i>Agonum fuliginosum</i> (Panz.) | 15 | 1 | 17 | — |
| <i>Agonum livens</i> (Gall.) | — | — | 8 | — |
| <i>Agonum micans</i> Nicol. | 14 | — | 6 | — |
| <i>Agonum moestum</i> (Duft.) | 8 | 4 | 38 | 4 |
| <i>Agonum muelleri</i> (Herbst) | 1 | 2 | — | 1 |
| <i>Agonum obscurum</i> (Herbst) | 3 | — | 31 | — |
| <i>Amara aenea</i> (Deg.) | — | — | 1 | — |
| <i>Amara communis</i> (Panz.) | 1 | — | — | 1 |
| <i>Amara convexior</i> Steph. | 2 | 11 | 1 | — |
| <i>Amara familiaris</i> (Duft.) | 3 | 1 | — | — |
| <i>Badister lacertosus</i> Sturm. | 3 | 2 | — | — |
| <i>Badister sodalis</i> (Duft.) | 1 | — | — | 1 |
| <i>Bembidion biguttatum</i> (F.) | — | — | 5 | — |
| <i>Bembidion unicolor</i> Chaud. | 227 | 4 | 35 | 5 |
| <i>Calosoma inquisitor</i> (L.) | — | 3 | 3 | 12 |
| <i>Carabus coriaceus</i> L. | — | — | 6 | 33 |
| <i>Carabus granulatus</i> L. | 52 | 81 | 149 | 50 |
| <i>Carabus scheidleri</i> L. | 1 | 3 | 1 | — |
| <i>Clivina fossor</i> (L.) | 2 | — | 15 | — |
| <i>Cychrus attenuatus</i> F. | 10 | 31 | 2 | 2 |
| <i>Elaphrus cupreus</i> Duft. | 6 | 1 | 4 | 1 |
| <i>Harpalus latus</i> (L.) | 1 | 7 | — | 8 |
| <i>Harpalus punctatulus</i> (Duft.) | — | — | — | 2 |
| <i>Leistus ferrugineus</i> (L.) | 24 | 7 | 56 | 47 |
| <i>Leistus rufescens</i> (F.) | — | — | 15 | 2 |
| <i>Loricera pilicornis</i> (F.) | — | 3 | 33 | 4 |
| <i>Nebria brevicollis</i> (F.) | — | — | 22 | 5 |
| <i>Notiophilus biguttatus</i> (F.) | 14 | 20 | — | 2 |
| <i>Oodes helopioides</i> (F.) | 3 | — | 4 | — |
| <i>Patrobus atrorufus</i> (Stroem) | 1126 | 73 | 2252 | 706 |
| <i>Pterostichus anthracinus</i> (Illig.) | 35 | 4 | 196 | 14 |
| <i>Pterostichus cupreus</i> (L.) | — | 2 | — | — |
| <i>Pterostichus minor</i> (Gyll.) | 1 | — | 8 | — |
| <i>Pterostichus niger</i> (Schall.) | 1 | 63 | 128 | 98 |
| <i>Pterostichus nigrita</i> (Payk.) | — | 2 | 13 | 4 |
| <i>Pterostichus oblongopunctatus</i> (F.) | 20 | 475 | 144 | 877 |
| <i>Pterostichus strenuus</i> (Panz.) | 242 | 258 | 150 | 32 |
| <i>Pterostichus melanarius</i> (Illig.) | 6 | 36 | 92 | 329 |
| <i>Stomis pumicatus</i> (Panz.) | 9 | 8 | 1 | — |
| <i>Synuchus nivalis</i> (Panz.) | — | 1 | — | — |
| <i>Trechus quadristriatus</i> (Schrank.) | — | — | 1 | 1 |
| <i>Trechus secalis</i> (Payk.) | 179 | —60 | 173 | 153 |
| Total of species | 30 | 28 | 36 | 30 |
| Total of individuals | 2028 | 1371 | 3872 | 2719 |

where t is the number of accumulated samples whose values we do not consider independent.

The analysis of variance of the two-way classification with equal numbers per cell with interaction proved that in H values considered independent of the size of samples diversity significantly ($P < 0.001$) differed in the plots. No statistically significant difference was found in individual samples and interactions between plots and samples. The catches in individual traps on individual plots then did not significantly differ statistically, and were not significantly affected by the character of the plots. The investigated communities were therefore considered infinite and representative sensu Pielou (1966b), and the differences between individual plots in diversity were tested by Hutcheson's (1970) test

$$t = \sqrt{\frac{h_1 - h_2}{\text{var } h_1 + \text{var } h_2}}, \text{ where}$$

$$\begin{aligned} E h &= - \sum p_i \ln p_i - (s - 1)/2n + (1 - \sum p_i^{-1})/2n^2 + \sum (p_i^{-1} - p_i^{-2})/2n^3 + \dots \\ \text{Var } h &= [\sum p_i \ln^2 p_i - (\sum p_i \ln p_i)^2/n] + (s - 1)/2n^2 + (-1 + \sum p_i^{-1} - \sum p_i^{-1} \ln p_i + \\ &\quad + \sum p_i^{-1} \sum p_i \ln p_i)/6n^3 \dots \end{aligned}$$

for degrees of freedom

$$d. f. = [\hat{\text{Var}} h_1 + \hat{\text{Var}} h_2]^2 / \left[\frac{(\hat{\text{Var}} h_1)^2}{n_1} + \frac{(\hat{\text{Var}} h_2)^2}{n_2} \right]$$

RESULTS AND DISCUSSION

The total of 46 species and 10252 individuals of the family Carabidae were caught in both plots: 3400 individuals of 35 species in the Černínovsko nature reserve, and 6582 beetles of 42 species in the reserve Libický luh. They are surveyed in Table 1. The estimates of diversity are shown in Table 2.

Differences in the diversity of subassociations calculated by Hutcheson's (1970) test were significant for all plots. The greatest differences were found between the *Quercus-Ulmetum alnetosum* and *Quercus-Ulmetum carpinetosum* subassociations which markedly differ in humidity. The *Quercus-Ulmetum alnetosum* subassociation is extremely wet, flooded every spring (Pivníčková 1975). Because dominance usually reaches its minimum in the middle of a gradient (Rejmánek 1974), diversity is lower than in the *Quercus-Ulmetum carpinetosum* association, as it is shown in Table 2. The values of comparison of both subassociations were 14.2348 for the degree of freedom (d. f. = 2753) in Černínovsko, 14.1960 (d. f. 3705) between the subassociations *Quercus-Ulmetum alnetosum* in Černínovsko and *Quercus-Ulmetum carpinetosum* in Libický luh, 10.3962 (d. f. = 2644) between the subassociations *Quercus-Ulmetum carpinetosum* in Černínovsko and *Quercus-Ulmetum alnetosum* in Libický luh, and 9.71133 (d. f. = 6571) between the two subassociations in Libický luh.

The test showed substantially lower differences in the diversity of the same subassociations in different reserves, 2.7361 (d. f. = 2036) for *Quercus-Ulmetum carpinetosum* and 5.1404 (d. f. = 4633) for *Quercus-Ulmetum alnetosum*. The H' average diversity given in Table 2 is higher in both cases in the Černínovsko reserve affected by emissions. However, the values concerning the *Quercus-Ulmetum alnetosum* subassociation in Libický luh show a great standard error; diversity measurements for Hutcheson's (1970) test produced the value of 1.6394 for Černínovsko, whereas 1.8523 for Libický luh. Also in the subassociation *Quercus-Ulmetum carpinetosum* the resulting value was higher for Černínovsko, 2.2889 in contrast to 2.1824 in Libický luh.

Table 2. Comparison after Pielou (1966a) of the diversity of carabid beetles collected from pitfall traps throughout their active period in *Quercus-Ulmetum alnetosum* and *Quercus-Ulmetum carpinetosum* subassociations of oak-elm woods in the state nature reserves Černínovsko and Libický luh. The values are means \pm standard error

| Index of diversity | Černínovsko | | Libický luh | |
|--------------------|---------------------|---------------------|---------------------|---------------------|
| | Q. U. aln. | Q. U. carp. | Q. U. aln. | Q. U. carp. |
| H' | 2.3312 \pm 0.1681 | 3.0778 \pm 0.1659 | 2.1821 \pm 0.7097 | 2.9792 \pm 0.2862 |

The results agree with Ložek's (1979) conclusions: according to him the noxious effects of emissions have not yet become apparent in malacofauna, a community constituent very sensitive to change in chemism. Neither Pecina & Pivníčková (1975) found any pronounced manifestations of damage to the lower strata of the wood, soil and water in the composition of the fauna.

CONCLUSIONS

Comparable values of relative abundance obtained by means of pitfall traps throughout the active period of the investigated species were used for the calculation of diversity after Pielou (1966a), and after an analysis of the variance of diversity values considered independent the differences between the investigated plots were tested by Hutcheson's (1970) test. There was a marked difference in diversity between subassociations of two floodplain forests; effects of noxious emissions on one of the plots have not been proved.

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**A NEW COLEOPTERIFORM GENUS AND SPECIES OF CERATOCOMBIDAE FROM
ZAIRE (HETEROPTERA, DIPSOCOROMORPHA)**

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Abstract: *Feshina schmitzi*, gen. et sp. n. (Ceratocombinae: Ceratocombini) based on a coleopteriform elytrid male is described from Zaire. Besides its unique general facies and characters of male abdomen it differs from other Ceratocombini by a schizopterid-like construction of propleuron. Two keys to genera of Ceratocombidae are provided, one based on somatic characters, the other on characters of male abdomen.

Recently (Štys, 1982b), I have revised the suprageneric classification of Ceratocombidae and attempted to interpret the cladogenesis of the family. In the genus *Kvamula* Štys, 1982 I have described besides male-based species also *K. coccinelloides* Štys, 1982 (Vietnam) based on a coleopteriform elytrid female, a morph previously unknown in Ceratocombidae but not infrequently occurring in the related and also semiedaphic family Schizopteridae. A new genus and species of Ceratocombini based on another coleopteriform and elytrid specimen, this time a male from Zaire, is described in the present paper. Originally, I took it for a representative of Schizopteridae since the construction of its propleuron is almost identical with that of the latter family. Relationships of the new genus are discussed with reference to my recent paper (Štys, 1982b); the morphological terminology applied to male terminalia is based on my earlier study (Štys, 1970). Two generic keys to Ceratocombidae are included, one based solely on somatic characters, the other on characters of male terminalia.

I am greatly indebted for a loan of extensive African material of Dipsocoromorpha in which the presently described species has been found to Dr. Guy Schmitz (Musée Royal d'Afrique Central, Tervuren, Belgium); the species is named in his honour.

Feshina gen. n.

Etymology: derived from *Feshi*, the type locality of the type species; gender feminine.

Type species: *Feshina schmitzi* sp. n., monobasic.

Diagnosis. Coleopteriform elytrid male. With characters of Ceratocombinae: Ceratocombini as specified by Štys (1982b). Labium reaching procoxae, 4-segmented. Eyes short, high, diagonal. Collum large, well delimited. Propisternal lobe not extending below eyes, but large, developed as in Schizopteridae; prosupracoxal cleft long; base of fore coxa covered by propleuron; propimeral lobe with a triangular process posterodorsally. Apex of mesoscutellum subspinously produced. Fore wings longer than abdomen, without veins and

fractures, not alveolate, jointly forming a strongly sclerotized, moderately convex dome; costal margin narrowly explanate. Tarsal formula 3—3—3. Fore tarsites 2 and 3 with ventral spines. Middle and hind tibiae with short remnants of bristle combs. Abdomen and terminalia symmetrical. Laterotergites 2—7 strongly sclerotized, 3—7 with dorsal inner laterotergites. Mediotergite 8 fused with laterotergites 8; sternum 8 discrete. Spiracles 6 and 8 marginal, 7 ventral. Parameres broad, caudally protruding out of the pygophore, their hypophysis bifid.

Differential diagnosis. *Feshina* can be easily distinguished from other ceratocombids by means of the below keys. For other comparative notes see Discussion.

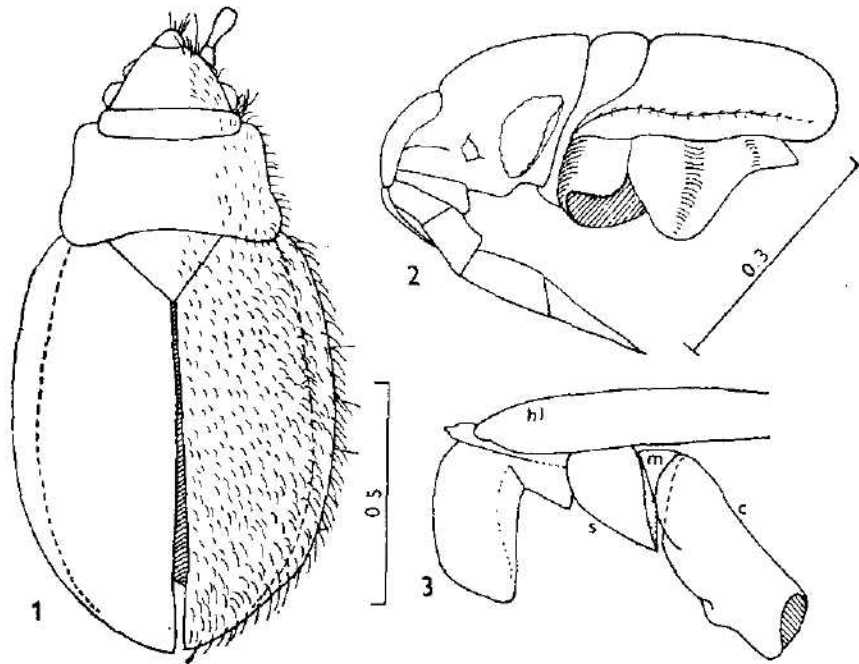
Key to genera of Ceratocombidae based on somatic characters

- 1 (2) Head strongly declivous. Pronotum strikingly short and transverse, Body outline broad, isometopine-like, costal margin of fore wings explanate. Pilosity uniform, without outstanding bristles. Membrane of macropters with 3 cells. Ceratocombinae: *Issidomimini* *Issidomimus* Poppius, *Kvamula* Štyš, *Muatianvuia* Wygodzinsky
- 2 (1) Head porrect. Pronotum moderately long, never strikingly transverse. Body outline not markedly broad, costal margin of fore wings usually not explanate. Pilosity of head, pronotum and legs with some outstanding bristles to spines. Membrane of macropters with 2—4 cells.
- 3 (8) Bristles not markedly conspicuous, more or less concolorous with other hairs. Eye without strikingly conspicuous, long central bristle. Membrane of macropters with 2—3 large cells. Ceratocombinae: *Ceratocombini*.
- 4 (5) Coleopteriform, elytrid, Collum large, conspicuous, sharply delimited. Proepisternal lobe large, prosupracoxal cleft long, base of fore coxa covered by propleuron *Feshina* gen. n.
- 5 (4) Macropterous to brachypterous. Collum moderately developed, rather inconspicuous, often incompletely developed. Proepisternal lobe minute, prosupracoxal cleft not developed, base of fore coxa exposed.
- 6 (7) Membrane of macropters with 3 large cells (sometimes with additional minute ones) *Ceratocombus* Signoret
- 7 (6) Membrane of macropters with 2 cells *Leptonannus* Reuter
- 8 (3) Bristles strikingly conspicuous, strong and long, darker than normal hairs. Eye with outstandingly long and strong central bristle. Membrane of macropters with 4 large cells. *Trichotonanninae* *Trichotonannus* Reuter

Key to genera of Ceratocombidae based on male abdomen and terminalia

- 1 (2) Abdominal segments 7—9, laterotergites 7—9 and parameres asymmetrical. Laterotergites 7 appendage-like. Laterotergites 9 developed as processes of the pygophore; the latter with a large dorsal bridge. *Trichotonanninae* *Trichotonannus*
- 2 (1) Abdominal segments 7—9 and laterotergites 7—9 symmetrical; parameres symmetrical or asymmetrical. Laterotergites 7 not appendage-like. Laterotergites 9 developed as appendages articulating with tergum 8; pygophore without dorsal bridge or with its inconspicuous remnant. Ceratocombinae.
- 3 (4) Laterotergites 8 free, appendage-like. Parameres symmetrical *Ceratocombus*, *Leptonannus*, *Muatianvuia*
- 4 (3) Laterotergites 8 not appendage-like.
- 5 (6) Parameres asymmetrical, slender *Issidomimus*
- 6 (5) Parameres symmetrical.
- 7 (8) Parameres slender, their hypophysis not forked. Dorsal laterotergites of pregenital segments hardly sclerotized, without inner laterotergites. Laterotergites 8 discrete, spiraculate, mediotergite 8 fused with sternum 8. All abdominal

- spiracles dorsal' Kvamula
 ♂ (7) Parameres broad, their hypophysis forked. Pregenital segments with strongly sclerotized dorsal laterotergites provided with inner laterotergites on segments 3-7. Laterotergites 8 fused with mediotergite 8; sternum 8 discrete. Abdominal spiracles 6 and 8 marginal, 7 ventral Feshina gen. n.



Figs. 1-3. *Feshina schmitzi*, ♂ holotype. 1 — Total view. 2 — Head, labium and prothorax, lateral view; hairs omitted. 3 — Pteropleuron, lateral view; hairs omitted.

Lettering: c = metacoxa; hl = hypocostal lamina; m = metepimeron; s = metepisternum.

Feshina schmitzi, sp. n.

(Figs. 1-18)

Holotype: ♂, Zaire, Kwango Prov., Feshi, left bank of Kwange R., iii. 1959, leg. Mme J. Leleup (habitat No. 70, „tête de source de la Mvula Myeji“, forest); Muséum Royal d'Afrique Centrale, Tervuren. Flagella of antennae missing; left legs and abdomen separated from the dry mounted-specimen and preserved in glycerine microvial.

Coleopteroid male.

Measurements (L = length, W = width, all in mm). Head, L 0.19, max. W 0.30, min. W vertex 0.21. Antenna, approx. L of segment I 0.065, II 0.095. Labium L segment I 0.03, II 0.06, III 0.09, IV 0.12. Pronotum, medial L 0.27, anterior W 0.38, posterior (max.) W 0.51, collum L 0.07. Scutellum, proximal W 0.24, L 0.18. Combined elytra, L commissure 0.70, proximal W. 0.50, max. W 0.70.

Total length 1.35 mm.

General facies (Fig. 1). Strongly sclerotized, moderately elongate and moderately convex, coleopteroid, vaguely resembling a non-sculptured hydraenid beetle. Body 1.91 times as long as wide.

Coloration. Dorsum unicolorous, castenous (elytra sublaterally slightly darker, anterior part of pronotum and head gradually paler anteriorly, yellow-brown), extremities stramineous.

Cuticle matt, microgranulate, without distinct features.

Pilosity dense, moderately long, adpressed to semierect, but hairs (with the exception of spiniform tibial and fore tarsal bristles) always soft; a few outstanding erect hairs present on head, but also these similar to normal setae. Hairs curved, pale, with strong silvery to golden reflections.

Head (Figs. 1, 2) moderately porrect, epicranium simply convex, moderately slanting; antenniferous tubercles minute, distant from eyes. Eyes small, much higher than long, diagonal, coarsely faceted, posteroventrally with a few short intermatidial setae; ocular index approx. 4.33. Postocular part not developed, but eyes not particularly adpressed to the pronotum. Ocelli absent. Posterior margin of vertex simple, not sharp. Bucculae just embracing the base of labium, not extending caudad of antenniferous tubercles, proximally high and conspicuous; ventral profile of head roundedly obtusangular immediately below eyes. Dorsum of head with semierect but very short pubescence, some longer and more outstanding hairs at the anteclypeus and near its base.

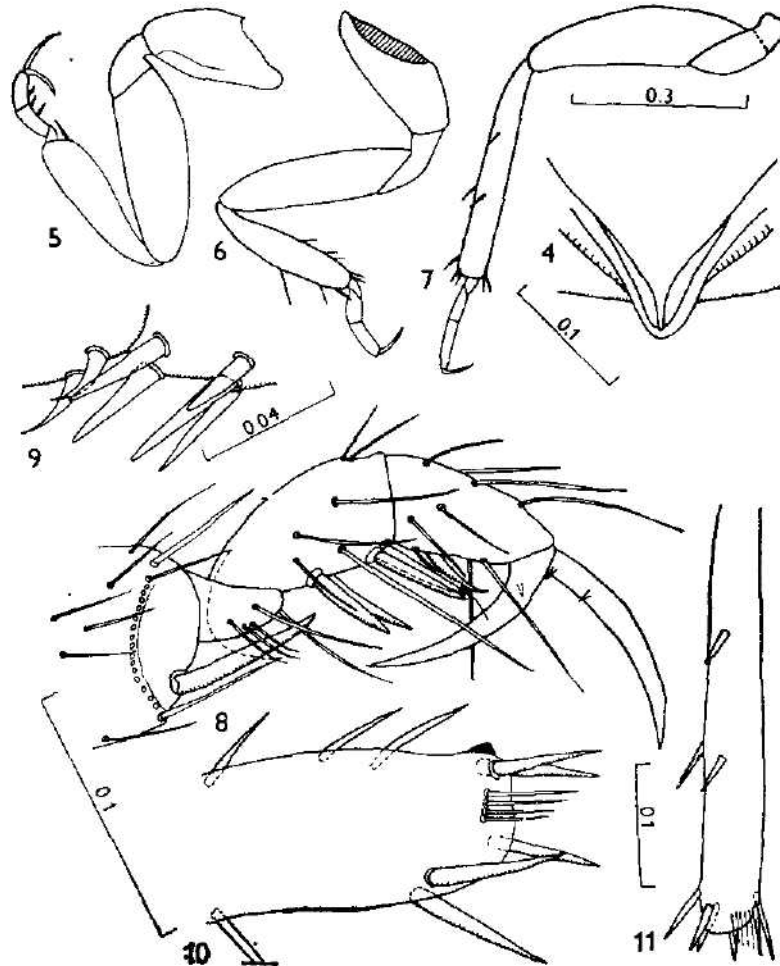
Second antennal segment about 1.5 times as long as first, subclavate (Fig 1).

Labium (Fig. 2) thick and short, reaching between fore coxa, 4-segmented, first segment shorter than bucculae but visible even laterally, penultimate segment 0.75 times as long as the last one.

Thorax. Pronotum (Figs. 1, 2) transverse, 1.88 times as wide as long, 0.75 times as wide anteriorly as posteriorly, subtrapezoidal with rounded angles; collum long, perfectly delimited, continuous with the sternum, posterolateral margin embraced by the main lobe (dorsal view); lateral margins of the latter anteriorly straight and slightly divergent, posteriorly rounded and, consequently, appearing moderately concave; posterior margin concave. Surface of pronotum almost flat, horizontal, with short, sub-adpressed pubescence, without erect hairs. Lateral margin of pronotum sharp, rounded humerally, notopleural sulcus running ventromesad to the former and sharply delimiting pleural lobes. Proepisternal lobe (Fig. 2) large, resembling that of a schizopterid, but ventrally directed and not produced below eye; supracoxal cleft reaching to notopleural culex; proepimeral lobe posteriorly extensively depressed, posterodorsally produced in a triangular extension separated by a wide cleft from the notum. Prosternum simply triangular. Mesoscutellum triangular, with straight sides, wider than long, densely diagonally pilose; apex with a spiniform extension (Fig. 4) visible only under a high magnification. Pteropleuron as illustrated (Fig. 3), metepimeron mostly hidden by metacoxa. (Pterosternal region partly damaged during dissection, but without any conspicuous specialized features; mesosternum large, metasternum mostly membranous, with a medial gland opening.)

Fore wings (Fig. 1) modified into strongly and homogeneously sclerotized elytra meeting in a straight commissure and considerably exceeding the apex of abdomen; ratio length of elytron: maximum width of combined elytra 1.25, maximum width of combined elytra: proximal width of combined elytra 1.42, and maximum width of combined elytra: commissural length 1.00. Venation and fractures absent, costal margin rather narrowly explanate but not delimited by any groove, the proximal part of the explanate area concave and markedly different from the moderately convex rest of the elytron, distal part of

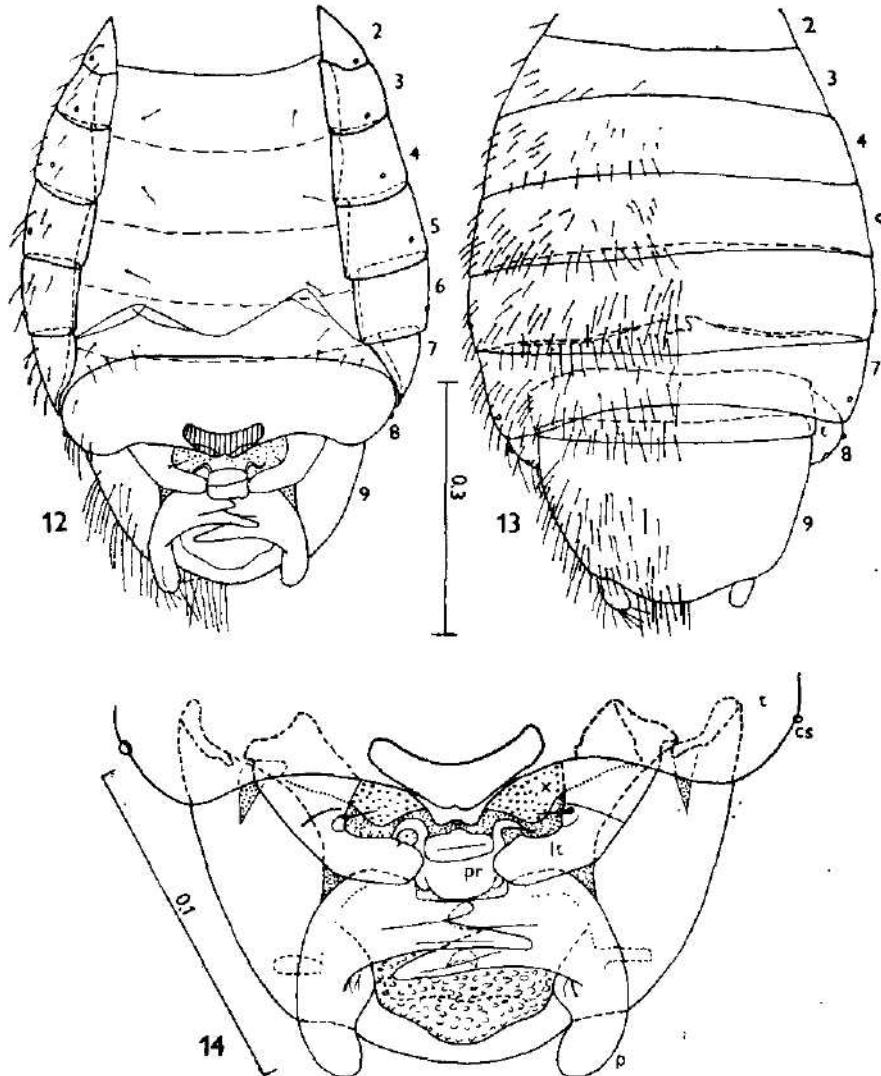
the explanate area flat, not sharply delimited, narrowing and disappearing distad. The elytra jointly forming an elongate, low and only moderately convex dome over the abdomen. Elytra densely covered with suberect, short (proximally) to adpressed, long (distally) curved hairs; those of the lateral margin forming a hairy fringe interspersed with a few soft erect setae. Hypocostal lamina broad, proximally mesally sharply delimited, narrowing, gradually disappearing and losing its identity in the distal half of the elytron; hypocostal lamina developed as a ventrolateral thickening of the elytron fused with its



Figs 4—11. *Feshina schmitzi*, ♂ holotype. 4 — Apex of mesoscutellum; hairs omitted. 5—11 — Left legs, cleared 5—7 — Fore (5; anterior view), middle (6; posterior view) and hind (7; posterior view) leg; only spiniform bristles shown. 8 — Apical part of fore leg, anterior view (not all tarsal spines shown, cf. Fig. 9). 9 — Spines of fore 2nd and 3rd tarsite, posterior view. 10 — Apex of middle tibia, posterior view; only bristle-comb and spines shown. 11 — Distal part of hind tibia, posterior view; only bristle-comb and spines shown.

dorsal surface, not as a laminar reflection of the wing. Ventral surface of the elytron (except for hypocostal lamina) very pale, with dense blackish dots corresponding to insertions of dorsal hairs. Hind wings absent.

Legs (Figs. 5—11). Fore legs stout and short, middle and hind ones gradually more slender. Fore tibia thick, with conspicuous erect pilosity longer than tibial diameter on dorsal side, with an anterior subterminal transverse cleaning comb



Figs. 12—14. *Feshina schmitzi*, ♂ holotype; abdomen and terminalia, cleared. 12, 13 — Abdomen, dorsal (12) and ventral (13) view. 14 — Posterior margin of tergum 8, pygophore and associated structures, dorsal view; hairs omitted.

Lettering: cs = campaniform sensillum; lt = laterotergite 9; p = paramere; pr = proctiger; t = tergum 8; x = possible remnant of dorsal pygophoral bridge.

of about 17 setae; the comb bordered by two long subspiniform setae; ventral apex of tibia with a strong terminal spine, otherwise no spines or spiniform bristles present (Fig. 8). Middle (Fig. 10) and posterior (Fig. 11) tibiae with a reduced posterior cleaning comb each, of 4 and 5 setae respectively; distribution of spines and spiniform bristles as illustrated, spines of the hind tibia strikingly different from other hairs. Tarsal formula 3—3—3, fore tarsi stout and strongly curved (Fig. 8), middle tarsi more moderately curved and less thick, hind tarsi straight and slender. Fore second tarsite with 3+2 straight ventral spines, third tarsite with two curved and tapering ventral spines (Figs. 8, 9). Claws very slender, moderately curved; those of fore legs with two small microtrichial spiniform processes (Fig. 8). No other pretarsal structures recognized with certainty, but the presence of minute arolia on fore and middle legs and paired setiform extensions of unguitractor plates (parempodia) on middle and hind legs cannot be excluded.

Pregenital abdomen (segments 1 and base of 2 not studied, impaired during dissection) — Figs. 12, 13. Basic construction of segments 2—7: sclerotized and moderately convex ventrite separated by a sharp connexival edge from flat and strongly sclerotized dorsal laterotergites reflected over lateral parts of semimembraneous mediotergites. Intersegmental boundaries between mediotergites 2—7 rather indistinct, the latter without sclerites; mediotergite 7 folded over 6 and under 8; no traces of apertures of dorsal glands; mediotergites bare except for 1+1 lateral seta on 3—6 and a transverse posterolateral row of 3+3 setae on 7. Dorsal laterotergites 2 and 7 triangular, 3—6 subrectangular, 3—6 slightly overlapping the anterior margins of 4—7; 3—7 provided with dorsal inner laterotergites reflected under the mesal margins of external laterotergites; all external laterotergites sparsely pilose. Ventrites 2—4 not overlapping, 5—7 overlapping anterior margins of 6—8, all densely pilose. Anterior margin of ventrite 7 with an apodeme, anteromedial margin of ventrite specialized, excised as illustrated (Figs. 13, 18).

Segment 8 (Figs. 12—15) composed of a small sternum (posterior margin straight) and a large, continuously sclerotized tergum formed by fusion of the mediotergite with laterotergites (including their ventral elements); consequently tergum laterally reflected ventrad (Fig. 13). Tergum 8 simple except for its specialized posteromedial margin provided with a strongly sclerotized, broadly U-shaped structure produced in a short process (Figs. 14, 15); mostly bare, pilose in originally laterotergal areas only; lateral margin rounded, with a pair of conspicuous campaniform sensilla (Fig. 14) in anterior third (left one much larger than the right one).

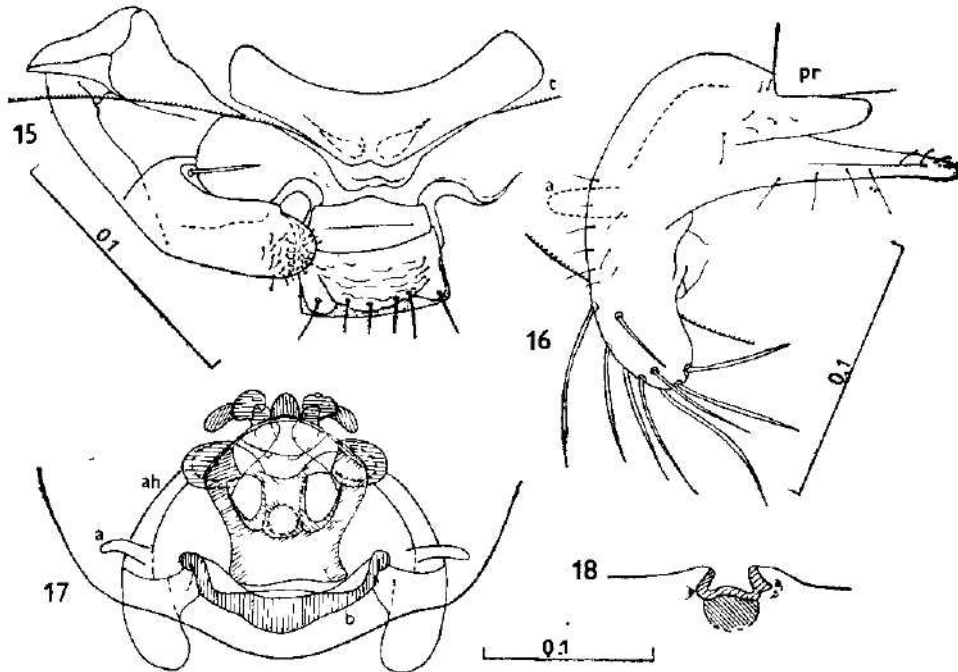
Spiracles (Figs. 12, 13) 2—5 dorsal on dorsal external laterotergites; 6 marginal (probably situated between the dorsal laterotergite and the ventrite); 7 ventral submarginal, on the ventrite; 8 ventromarginal, on the tergum, posterior to campaniform sensilla.

Terminalia*) symmetrical (minor asymmetries observed only in the

*) Owing to the uniqueness of the specimen and its small size the terminalia have not been dissected and were studied *in situ*. Consequently, some details could not be ascertained, or the interpretation of the shape and association of some structures is dubious. This concerns (a) shape of the posterior foramen of pygophore, (b) nature and association of a structure considered a possible remnant of tergal bridge 9, (c) shape of the anterior margin of the shorter process of the parameral hypophysis, (d) nature of ventral transverse apophysis of the paramere (parameral or pygophoral?), and (e) construction of the phallus.

detailed shape of apices of laterotergites 9; also the longer process of the hypophysis seems to be thicker on the right paramere).

Laterotergites 9 as illustrated (Figs. 14, 15), associated with posterior margin of tergum 8 and apodemes of the anterodorsal angle of the pygophore; mesal margin with one long seta, apex with many minute macrotrichia; distal parts partly overlapping the parameres and the proctiger.



Figs. 15—18. *Feshina schmitzi*, ♂ holotype; abdomen and terminalia, cleared. 15 — Posteromedial margin of tergum 8, left laterotergite 9 and the proctiger; dorsal view. 16 — Left paramere; dorsal view *in situ*. 17 — Parameres and phallus as seen *in situ* through the wall of the pygophore, ventral view; hairs omitted. 18 — Specialized anteromedial margin of ventrite 7.

Lettering a = transverse apophysis of paramere, ah = apodeme of parameral hypophysis; b = basal apparatus of phallus, pr = proctiger, t = tergum 8.

Pygophore (Fig. 14) broadly conical, posterior margin laterally shallowly concave, medially simply rounded; lateral dorsal parts broad, smooth; postero-medial dorsal sector terminally smooth, subterminally curved and vaulted according to the shape of the basal apparatus of phallus (Figs. 14, 17) and with a scale-like microsculpture; the sculptured part extending cephalad below the parameral hypophyses (the shape and position of the posterior margin of posterior foramen of the pygophore not ascertained); pygophore simply pilose, the sculptured area bare. A distinct pygophoral tergum or tergal bridge absent, but a semisclerotized structure (Fig. 14: x) situated along the medioposterior margin of tergum 8, ventrad to its process and mesad to laterotergites 9, possibly representing a remnant of the bridge.

Proctiger as illustrated (Fig. 15), composed of a membranous rectangular envelope, smooth, transverse, basal sclerite, wrinkled, tri-lobate distal sclerite (its posterior margin with 6 setae) and an anterolateral pair of sinuate apodemes.

Parameres as illustrated (Figs. 14, 16, 17); base associated with the basal apparatus of phallus; distal parts broad, horizontal, formed by a caudal, elongately rounded process distally protruding out pygophore, and a laterally rounded hypophysis which is mesally forked and produced into two processes (those of the left paramere crossing over those of the right one). Ventral surface of paramere (Fig. 17) with a laterally directed transverse apophysis (belonging to the paramere or to its pygophoral articulation?) and a strong apodeme along the lateral margin of hypophysis. Chaetotaxy as illustrated (Fig. 16).

Phallus observed only in situ through the ventral wall of pygophore; its shape as illustrated (Fig. 17). Basal apparatus simple, transverse, contacting bases of parameres and apposed to the ventral surface of the posterodorsal wall of pygophore. No long processus gonopori has been observed.

DISCUSSION

a) Family position of *Feshina* and construction of its propleuron

Feshina schmitzi is, in spite of its unique general facies, clearly a member of Ceratocombidae. Symmetrical male terminalia never occur in Dipsocoridae, Hypsipterygidae and Schizopteridae (cf Emsley, 1969; Štys, 1970). Coleopterism is known in Schizopteridae, but *Feshina schmitzi* lacks the metacoxal pads characteristic of the latter family. Its second antennal segment being considerably longer than first suggests ceratocombid affinity: the reverse situation is the rule in Schizopteridae (Emsley, 1969), though a few schizopterid genera are ceratocombid-like in this respect (e. g. *Dictyonannus* Gross, 1950 and *Nannodictyus* Štys, 1982 — cf. Štys, 1982a). The only discordant feature of *Feshina* is the construction of its propleuron.

The propleuron of Ceratocombidae is characterized by a reduced episternal lobe — it is minute, does not join the large epimeral lobe, and, consequently, no normal supracoxal cleft it formed and the base of fore coxa and its articulation are externally visible (Štys, MS in prep.). The propleuron of Schizopteridae possesses a large, inflated proepisternal lobe (usually, but not always, extending anteriorly below eyes) which meets the proepimeral lobe along an extended supracoxal cleft as in most Heteroptera; consequently, the base of fore coxa and its articulation are not exposed but covered by propleuron.

The propleuron of *Feshina schmitzi* (Fig. 2) is constructed as in Schizopteridae and strikingly differs from the ceratocombid condition. A clue to appreciation of this situation is provided by the coleopteriform elytrid female of *Kvamula coccinelloides* Štys, 1982 (Ceratocombinae: Issidomimini) — its propleuron is constructed as in *Feshina schmitzi* and Schizopteridae while that of macropterous *Kvamula* males is typically ceratocombid-like (a character I failed to notice in my 1982b paper). It can be concluded that *coleopterism in the Ceratocombidae results in development of schizopterid-like propleuron*; consequently, this striking character apparently is of a very low diagnostic weight, though its evolutionary appreciation will be important for the understanding of anagenesis of heteropteran pleuron and interpretation of cladogenesis of dipsocoromorph families.

b) Relationships of *Feshina*

Both male terminalia and somatic characters of *Feshina schmitzi* suggest that this species does not belong to Trichotonanninae or Ceratocombinae: Issidomimini as defined by Štys (1982b). It must be classified in Ceratocombinae: Ceratocombini, a possibly paraphyletic (no synapomorphies known) but clearly defineable tribe. *Feshina* differs from other Ceratocombini by apomorphic fusion of laterotergites 8 with mediotergite 8 (a character convergent to *Issidomimus*) — the diagnosis of the tribe (Štys, 1982b) has to be amplified in this respect. The ventral shift of abdominal spiracles 7 is an autapomorphy of *Feshina*. The existence of a possible remnant of dorsal pygophoral bridge (cf. Fig. 14: x) in *Feshina schmitzi* would be an autplesiomorphic character within Ceratocombinae, approaching the condition found in Trichotonanninae; however, the nature of this structure is uncertain and, moreover, it could have easily been overlooked in the other genera of Ceratocombinae. Consequently, it is not clear whether *Feshina* is a sister taxon to *Ceratocombus* & *Leptonannus* or an apomorphic off-shoot of this not yet analyseable complex.

A unique character of the male of *Feshina schmitzi* seems to be its armature of spines on the ventral surface of its fore tarsus. A similar armature is known only in *Trichotonannus* species where this feature is sexually dimorphic and occurs in females only (cf. Wygodzinsky, 1953; Štys, 1977). It is probable that the tarsal spines function as an attachment device during mating; hence we can anticipate different modes of copulation and reverse position of sexes in *Trichotonannus* species and *Feshina schmitzi*.

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**SURVIVAL OF CYSTICERCIDS OF THE FAMILY HYMENOLEPIDIDAE IN
DEAD INTERMEDIATE HOSTS (COPEPODA, OSTRACODA)**

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Received September 7, 1981

Abstract: Survival of cysticeroids of 5 cestode species (*D. coronula*, *F. fasciolaris*, *M. compressa*, *M. paracompressa* and *S. gracilis*) in 7 species of Copepoda and Ostracoda (*A. vernalis*, *A. viridis*, *C. strenuus*, *E. serrulatus*, *M. albidus*, *M. crassus* and *D. fasciata*) was studied under experimental conditions. The cysticeroids were found to survive in dead intermediate hosts for 20–24 h in tap water and for 14–18 h in water from pond or experimental aquaria at 4–6 °C, for 16–17 h and 10–11 h, respectively, at 12–14 °C, for 10–12 h and 6–7 h, respectively, at 18–20 °C and for 5–6 h and 3–4 h, respectively, at 24–26 °C. After these periods the cysticeroids were still capable of further development in the definitive host.

INTRODUCTION

With regard to the breeding technology in large-scale breeding farms of water fowl in ponds it is important to know the source and course of infection with their most common enterohelminths, the cestodes of the family Hymenolepididae. They belong to the biohelminths and employ most frequently Copepoda and Ostracoda as intermediate hosts. The crustaceans live for a rather short time (infected specimens for 3–6 weeks) and for a further development of the cestodes it is necessary that live cysticeroids get into the digestive tract of the definitive hosts feeding on the crustaceans (in the littoral or even dead). Cysticeroids of some cestode species are known to survive in water snails — their paratenic, reservoir, or, after Odening (1976), paradefinitive hosts — for a long time without losing the ability of further development into adult stage. The cysticeroids get into the digestive tract of snails with the food (infected and dead crustaceans) and they accumulate in the ultimate tubules of hepatopancreas (a depositing type — for details see Ryšavý 1962 and Valkounová 1971, 1972 and 1973). The time for which the cysticeroids survive their hosts, planktonic crustaceans, is important for the infection of the definitive hosts and, particularly, for the accumulation of cysticeroids in water snails. The results summarized in the present paper were obtained during the experiments carried out in 1968–1972 and can be used in both experimental and field studies.

MATERIAL AND METHODS

Naturally and experimentally infected crustaceans were killed by pricking a preparation needle into anterior portion of cephalothorax and then put in Petri dishes in tap water (pH 6.4–6.7), water from experimental aquaria (pH 6.8–7.0) (Valkounová 1980) and pond water (pH 6.8–7.0). The experiments were performed at water

temperatures of 4–6 °C, 12–14 °C, 18–20 °C and 24–26 °C. The survival of five cysticeroid species was studied at each temperature range. The following species were used: *Dicranotaenia coronula* (Dujardin, 1845), *Fimbriaria fasciolaris* (Pallas, 1781), *Microsomacanthus compressa* (Linton, 1782), *M. paracompressa* Czaplinski, 1956 and *Sobolevicanthus gracilis* (Zeder, 1803). The crustaceans belong to the following species: *Acanthocyclops vernalis* (Fischer), *A. viridis* (Jurine), *Cyclops strenuus strenuus* (Fischer), *Eucyclops* (s. str.) *serrulatus* (Fischer), *Macrocyclus albidus* (Jurine), *Mesocyclops* (*Thermocyclops*) *crassus* (Fischer) and *Dolerocypris fasciata* (O. F. Müller).

In the whole, 60 experiments were carried out: 12 experiments with each cysticeroid species, i. e., 3 experiments at each temperature range. Twenty crustaceans of the same species infected with 1–7 cysticeroids were used in each experiment. A mixed infection with cysticeroids of 2–3 cestode species was studied in 10 experiments.

The survival of cysticeroids from dead crustaceans under natural conditions at the temperatures of 18–20 °C was studied in 20 cases: 6 specimens of *A. viridis* were infected 1–3 cysticeroids of *M. paracompressa*, 4 specimens of *A. vernalis* were infected with 2–5 cysticeroids of *D. coronula* and 10 specimens of *M. crassus* were infected with 2–10 cysticeroids of *F. fasciolaris*.

The viability and infection ability were verified by feeding experiments with 4-week-old *Anas platyrhynchos* dom. L. free from helminths and snails *Lymnaea peregra peregra* (Müller) and *L. peregra ovata* (Drap.).

RESULTS

Three time periods were considered while evaluating the survival of cysticeroids in the intermediate hosts (Table 1):

- 1) period for which the cysticeroids were live, movable, without any apparent changes in their inner structures and capable of developing into adults in the digestive tract of the definitive host;
- 2) period, during which the movement of the cysticeroids gradually ceased, their hooks were widely turned away from the rostellum, individual layers became indistinct and cells of the layers ruptured (water penetrated into the body cavities of dead crustaceans and the cysticeroids passed from the isotonic medium to the hypotonic one);
- 3) period when the cysticeroid contents were no more differentiated, the cell structures disappeared, fibrous structures were loose, the cysts ruptured and the hooks were often separated from the rostellum.

The results show that the survival of cysticeroids in dead crustaceans is related with

- a) the temperature — the higher the temperature, the shorter the time for which they are able to survive,
- b) the water — the cysticeroids survive in tap water for a longer time than in water from experimental aquaria or in pond water.

The survival of cysticeroids was not affected by using different cysticeroid and intermediate host species (or mixed infections).

The survival of cysticeroids in naturally dying crustaceans was identical with the survival in experimentally killed crustaceans in all types of water used.

While interpreting our results it is recommended to use the lower values of the time range at the given temperature, though the time periods, except for 18–20 °C (Tab. 1, 18–20 °C, B 1.2), do not cover one another.

The cysticeroids designated as live and moving were fed to young ducks and they continued to develop in their digestive tracts. Moreover, the cysticeroids of *D. coronula*, *M. compressa* and *M. paracompressa* were fed to snails

Table 1. Survival of cysticercoids in dead crustaceans kept in tap water (A) and in water from aquaria and pond (B)

| Temperature (°C) | | 1. (hours) | 2. (hours) | 3. (hours) |
|------------------|---|------------|------------|------------|
| 4—6 | A | 20—24 | 25—30 | 31—34 |
| | B | 14—18 | 19—24 | 25—30 |
| 12—14 | A | 16—17 | 18—22 | 23—26 |
| | B | 10—11 | 12—16 | 17—18 |
| 18—20 | A | 10—12 | 13—16 | 17—20 |
| | B | 6—7 | 7—9 | 10—11 |
| 24—26 | A | 5—6 | 7—10 | 11—13 |
| | B | 3—4 | 5—7 | 8—10 |

1., 2., 3. — explained in Results.

in 7 experiments. They survived for two years without losing their infection ability (verified by 5 feeding experiments with ducklings). This two-year period is the longest hitherto recorded survival of cysticercoids in snails.

DISCUSSION

The cysticercoids of *F. fasciolaris* and *S. gracilis* are either swallowed together with the live intermediate host by the definitive host and continue to develop in its digestive tract or they survive in the dead intermediate host for a certain time and if they are not swallowed by the definitive host during this time, they die.

The cysticercoids of *D. coronula*, *M. compressa* and *M. paracompressa* have more possibility to survive under natural conditions. They survive in the snails in winter and in spring they are capable of infecting the definitive hosts — water birds feeding on the snails. The snails found in the mud of emptied ponds in spring were infected with the cysticercoids (the infection must have been acquired in the preceding year) which were able to continue their development after being fed to ducks (verified experimentally).

The use of different types of water in the experiments was substantiated by our previous experience with experimental infection of crustaceans with cestode eggs. The crustaceans can live in the tap water for a shorter time, but the bacteria multiply much more slowly in it. Consequently, we followed also the survival of cysticercoids in the tap water, as we supposed that this time period would be the longest and that the tap water would be suitable for the experiments under laboratory conditions (which is important for feeding experiments). Using the water from aquaria and pond we wanted to verify whether we managed to create in aquaria and pond we wanted to verify whether we managed to create in aquaria the living conditions most similar to those in nature. The values obtained were almost identical.

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FURTHER NOTE ON THE GROWTH OF THE COMMON BARBEL, *BARBUS BARBUS* (PISCES: CYPRINIDAE)

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Received April 28, 1983

Abstract: The sample of 18 specimens of the common barbel *Barbus barbus* (Linnaeus, 1758) was studied using the scale structure. It was collected in the area of the river Teplá in Karlovy Vary, highly protected for many years, but their growth, in comparison with other nonprotected localities was also slow.

INTRODUCTION, MATERIAL, METHODS

The growth data about the barbel were summarized by Oliva, Tandon, Johal (1979). Up to the present no further contributions about the growth of this species were recorded from Czechoslovakia. The sample collected towards the end of May, 1981, and donated by the Committee of the Fishery Union in Karlovy Vary (Mr. V. Dlouhý) is important because all specimens were caught in a protected area of the river Teplá directly in Karlovy Vary, where barbels and other fishes are not disturbed by angling; on the contrary, they are frequently fed by visitors. When examining the fish populations and obtaining barbels for artificial hatching the sample of scales was collected and sent to us for the determination of age. For my purpose the same method for the scale examination was used as described by Oliva, Tandon, Naiksatham (1979).

RESULTS AND DISCUSSION

I have summarized my data in Table 1. From the comparison of my results with the data of Oliva, Tandon, Naiksatham (1979), who also reported on the barbel's growth in neighbouring countries, the following is evident:

1. The growth of the barbels from the river Teplá was slower than of those from the Berounka during 1962—1976, but faster than of those from the river Morávka.
2. The barbels from the Teplá grew more slowly than those from the upper Dunajec in southern Poland, where, in the year 1963, natural conditions of a rarely visited and not polluted river still survived.
3. The growth rate seems to be most similar to the barbels (females) from the Dyje (compared with the data of Hochman and Jirásek, 1960).
4. Considerable growth increments are also evident in the barbels of higher age groups.

Table 1. Growth of Common Barbel, *Barbus barbus*, from the river Teplá in Karlovy Vary, May 31, 1981

| No. of spec. | Age group | Ave. body length in mm at the time of capture | Average back calculated body lengths in mm, ranges in | | | | |
|-------------------|-----------|---|---|------------------|------------------|------------------|------------------|
| | | | l ₁ | l ₂ | l ₃ | l ₄ | l ₅ |
| 1 | V | 230 | 47 | 92 | 139 | 178 | 210 |
| 2 | VI | 285 (280-290) | 55 (50-63) | 122 (121-124) | 158 (153-163) | 192 (190-195) | 224 (212-236) |
| 2 | VII | 360 | 55 (53-57) | 108 (103-113) | 166 (155-178) | 215 (193-237) | 265 (236-295) |
| 3 | VIII | 423 (380-460) | 65 (62-69) | 124 (113-131) | 182 (162-192) | 233 (212-244) | 274 (237-306) |
| 2 | IX | 440 (420-460) | 63 (60-67) | 111 (110-112) | 163 (162-165) | 204 (204-205) | 257 (211-270) |
| 3 | X | 460 (420-500) | 53 (48-56) | 111 (102-118) | 155 (138-165) | 198 (185-222) | 234 (220-261) |
| 4 | XI | 470 (420-520) | 62 (53-85) | 125 (106-145) | 167 (143-204) | 207 (180-229) | 237 (210-254) |
| 1 | XII | 500 | 56 | 144 | 188 | 229 | 271 |
| Average | | | 58 | 117 | 165 | 207 | 246 |
| Annual increments | | | 59 | 48 | 42 | 39 | 49 |

SUMMARY

The growth of the barbel in one section of the river Teplá gained in May, 1981 in Karlovy Vary was studied using 18 specimens. Despite the specimens having been caught in a strongly protected area their growth was relatively slow. Fish of 12 + years were recorded. Their annual increments remain comparatively large up to a relatively high age and therefore it is evident that barbels can achieve larger dimensions and age; however, their slow growth does not correspond to angler's wishes.

Acknowledgements

The author is indebted to the Ministry of Education of Spain and of Czechoslovakia for support my studies in Prague. Dr O. Oliva kindly suggested me to study this problem, read and corrected the typescript.

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brackets

| l_6 | l_7 | l_8 | l_9 | l_{10} | l_{11} | l_{12} |
|------------------|------------------|------------------|------------------|------------------|------------------|----------|
| — | — | — | — | — | — | — |
| 253 | — | — | — | — | — | — |
| — | — | — | — | — | — | — |
| 332 (332—333) | 345 (338—352) | — | — | — | — | — |
| 325 (288—370) | 369 (343—409) | 406 (369—445) | — | — | — | — |
| 295 (288—302) | 345 (340—350) | 379 (378—380) | 419 (406—433) | — | — | — |
| 282 (262—316) | 322 (298—368) | 366 (334—416) | 399 (356—450) | 435 (400—475) | — | — |
| 279 (243—307) | 327 (280—366) | 371 (315—439) | 408 (348—482) | 442 (382—510) | 465 (406—518) | — |
| 298 | 340 | 372 | 409 | 442 | 473 | 495 |
| 295 | 341 | 379 | 409 | 440 | 469 | 495 |
| 46 | 38 | 30 | 31 | 29 | 26 | |

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REVIEWS — RECENSE

Finerty J. P., 1980: *The Population Ecology of Cycles in Small Mammals: Mathematical Theory and Biological Fact*. xiv + 234 pages 83 figs., Yale University Press, New Haven and London, £ 13.00.

There exist several examples of oscillations in animal population density and some of these have been termed cyclic. The most extraordinary examples of oscillatory populations are in small mammals inhabiting the boreal forest and arctic tundra of northern hemisphere. These small mammal cycles can be separated into two categories: the 10-year cycle of North American boreal forest, notably snowshoe hares (*Lepus americanus*), muskrats (*Ondatra zibethicus*), and their predators; and the 4-year cycle of arctic tundra in Eurasia and North America, notably lemmings (*Lemmus* spp., *Dicrostonyx* spp.) and many other microtines, and their predators (*Mustelidae*, *Felidae*, *Canidae*). The existence of these "cycles" has raised many challenging questions over the years. Finerty's book tries to bridge the gap between theory and observation concerning the phenomena mentioned.

The purpose of the book is given in a quotation from the author's teacher Evelyn Hutchinson: "... to uncover possibilities, by any kind of theoretical analysis that proves helpful, and then to see how many of these possibilities are indeed realized in nature". The introductory chapter represents the discussion with Cole's opinion that population cycles in mammals could possibly be explained as random series. The second chapter brings a short and interesting historical review of cycles from 13th to 20th century. In the third chapter Finerty examines the existence of cycles by applying methods of time series analysis to population data. He concludes that a number of prey and their predators evidence regular population fluctuations which are basically local phenomena, although data reveal these oscillations on a larger scale. The fourth chapter, Causal Factors: Theories and Facts, treats the variety of hypotheses and formal theories which could be helpful in explanation of cycles (time-delay logistic growth, bifurcations, Volterra's predator-prey model, Kolmogorov's limit cycles, genetic-behavioral polymorphism, role of patchy habitat, epicentric migrations, etc.). A number of mathematical viewpoints has proven interesting but of limited usefulness. Levin's loop analysis of simplified ecological systems is used in the final chapter. It is only to be regretted that the author did not take into account proceedings of the symposium "Population dynamics of the field vole *Microtus agrestis*: a modelling study" (N. C. Stenseth, ed., 1977) and relevant sources of information from the Soviet Union (e. g., Danilov P. I., Rusakov O. S. and Tumanov I. L., 1979: *Chiščnye zveri Severo-Zapada SSSR*, Leningrad).

I found the book to be attractively laid out, stimulating, and above all a thoroughly enjoyable reading experience. It is a step toward the most complete understanding of population cycles. Overall, this book is an invaluable addition to the library of anyone who works on any aspect of animal population ecology.

M. Rejmánek

Haltenorth T. and Diller H., 1980: *A Field Guide to the Mammals of Africa including Madagascar*. 400 pages, 245 distribution maps, 38 black and white figs., 63 colour plates, Collins, London, £ 8.95.

African mammalian fauna consists of about 1570 species and belongs to 14 orders and 67 families; as a whole this fauna is more diverse than that of any other continent except South America. However, up to the present there has been no Field Guide to the mammals of the whole continent including the adjoining and outlying islands. The very popular "A Field Guide to the Larger Mammals of Africa" by J. Dorst and P. Dandelot (1970, 1972, ...) covers the African continent south of the Sahara and does not include Madagascar. Thirteen orders, 38 families and 324 species, containing the largest and middle-sized species are presented in the Haltenorth's and Diller's Field Guide. It includes about 90 species more than Dorst's and Dandelot's Guide. To keep the volume to a manageable size, very small, nocturnal or burrowing species, or those very rarely seen, were excluded. The

German original of the book (1977) was translated and slightly revised by R. W. Hayman.

Introductory chapters are dedicated to the geological and climatological history of Africa and Madagascar and to the history of the mammalian world of these areas. The main text is organized in such a way that after a summary of family characteristics, there are details of each species' appearance, measurements, weight, distribution, habitat, habits, movement, voice, sense organs, enemies, food, social life, breeding, growth, longevity and subspecific variation. Almost every species is illustrated in colour with supplementary drawings in black and white, including details of gazelle and guenon heads to aid identification.

There are only a few weaknesses in the book. The distribution map of Cape Buffalo (105) does not correspond to this ssp. only but to the whole species of African Buffalo. Kirk's Dik-dik (51) is not distributed in northern Kenya and Somalia (Kingdon 1982, p. 248). On the contrary, Lesser Galago (255) should be distributed over the whole Somalia (Kingdon 1971, p. 317). The authors accept rather a broad species concept which is questionable in some instances (e. g., fusion of *Kobus kob* (Erxleben, 1777) and *Kobus vardoni* (Livingstone, 1857) — cf. Matschie 1895, Dorst and Dandelot 1972, Dobroruka and Fejfar 1975, Kingdon 1982). Three important titles should be included in the Bibliography (J. Kingdon, 1971, 1974, 1977, 1979, 1982: East African Mammals I, IIA, IIB, IIIA, IIIB, IIIC, IIID, Academic Press, London; S. K. Eltringham, 1979: The Ecology and Conservation of Large African Mammals, Univ. Park Press, Baltimore; M. J. Delany and D. C. D. Happold, 1979: Ecology of African Mammals, Longman, London).

The authors, the translator and the publishers must be congratulated on a useful and beautiful book, which is designated not only for zoologists, but also for the broad public.

M. Rejmánek

Hiepe T., Ribbeck R.: *Lehrbuch der Parasitologie*, Bd. 4 — *Veterinärmedizinische Arachno-Entomologie*, 438 p., 190 illustr., 11 tab., VEB Gustav Fischer Jena, 1982, DDR 60,— M.

The steadily increasing significance of parasitology in medicine, biology and zoology has stimulated a similarly increasing appearance of more books in this area. Most of them, however, are devoted to human parasitology and only few are applied to veterinary parasitology. So this recently appearing four volume compendium by Prof. Dr. Theodor Hiepe and his collaborators of Humboldt University of Berlin is very welcome. (Vol. 1 appeared in 1981, Vol. 2 appeared in Jan. 1983, Vol. 3 will appear the next year. As they did in Vol. 1 the authors kept their encyclopaedic style and the book quickly and concisely informs all interested students on all necessary topics within this broad field. The subject matter and taxonomy are treated on a modern level. Each group of parasites is briefly diagnosed and genera and species are listed with short descriptions, together with hosts, bionomy or biological cycle, geographical distribution and epizootiology, pathology, diagnostics, and general control. Of advantage is the placement of selected and predominantly recent literature immediately after the text of each group.

In such an amount of material it is self-evident that the perfect balance of content (e. g. the important geographical distribution of *Wohlfahrtia magnifica* is lacking) or of relevancy (e. g. the Coleoptera are dealt with very widely, including vectors of helminths, whilst in Hemiptera the important species *Oeciacus hirundinis*, common in urban nests of *Delichon urbica* and invading human residents, is only mentioned in the text; the parasitic Copepoda are included very briefly, though they might be of interest to fish veterinarians) could not always be maintained. In this sense it could be considered for future editions to increase the repertoire of keys (e. g. key to principal groups of Rhynchophthirina). At the same opportunity the systematic position of the family Tarsonemidae (*Acarapis woodi*) should be corrected. But notes mentioned here do not reduce the high quality of the book.

Other advantages of the volume are the illustrations. They are mostly from the authors' departmental photographs and their instructiveness is surely greater than that of drawings in some books, where the abundance of details often veil the true nature of objects.

In summary, the revised book is good, useful and recommendable not only for parasitologists and veterinarians, but for arachnologists, entomologists and other zoologists as well.

J. Chalupskij

Singer R. (ed): *Effects of Acidic Precipitation on Benthos*. American Benthological Society, Hamilton, New York, 154 pp., 1982, Price \$ 10.00.

This volume represents proceeding of Symposium on effects of acidic precipitation on benthic organism held in Hamilton, New York, USA on August 8-9, 1980. It consists of 12 contributions written by 21 specialists from the USA, Canada and Scandinavia. Contrary to some previous studies focused mainly on investigation of acid lakes and production of fish these papers deal also with running waters and benthic organisms which are equally endangered by acidification caused by acid rain.

The papers can be divided into two larger groups. The first of them comprises the papers dealing with the physiological response of aquatic animals to lower pH: e. g. reduced survival and calorific content of stonefly and caddisfly larvae in acid water, role of benthic invertebrates (mayflies) in affecting sulphur and nitrogen dynamics of lake sediments or effects of acidified water on behavior and energy content of freshwater invertebrates. These contributions show physiological effects of acidification, which have previously escaped our attention, to be at least equally important to direct toxic effects of low pH.

The second group of contributions deals with effects of acidic precipitation from ecological or hydrobiological point of view. These papers describe changes caused by acidification in macroinvertebrate drift in streams and in composition and secondary production of insect communities. A large number of these changes manifest themselves only at population level but they are extremely important for invertebrates-fish trophic relationships.

Some important methodological contributions can be found in this volume as well. The methods for assessing the benthos of acidifying lakes are described in detail. Also the newly described methods using bivalvian shells as a paleoecological indicator of trophic status and pH values is worth of our attention.

Acidification of both standing and running waters represents one of the most serious problems from the water pollution point of view. Although the problem of acidic precipitation is being intensively studied in many countries this conference represent a serious attempt to summarize the effects of acidification from the biological point of view. Such a meeting is urgently needed also in Europe where much less attention (perhaps except for Scandinavia) is devoted to these questions.

T. Soldán

POKYNY PRO AUTORY

Věstník Československé společnosti zoologické uveřejňuje původní vědecké práce členů společnosti v rozsahu nejvýše 30 stran rukopisu, napsané v některé z kongresových řečí, a dále články, hodnotící životní dílo našich zoologů, vyžádané redakcí. Práce autorů, kteří nejsou členy společnosti, budou přijímány jen výjimečně.

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Hlavička práce. 1. Název pracoviště. 2. Název práce (u prací taxonomických v závorce za názvem systematické zařazení druhu nebo skupiny — např. Ostracoda: Cyprinidae), obojí v řeči, v níž je práce psána. 3. Jméno a příjmení autora.

Vlastní práce: 1. Velmi stručný abstrakt, v rozsahu nejvýše 15 řádek, v angličtině. 2. Úvod do problematiky (stručně). 3. Materiál a metodika (u známých metod pouze odkaz). 4. Vlastní část experimentální nebo popisná. 5. Diskuse. 6. Závěr. 7. Seznam citované literatury (nikoliv bibliografie!). 8. Adresa autora. 9. Tabulky, texty k obrázkům a grafům. Celý rukopis je průběžně stránkovan.

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Přepis cyrilice proveďte podle mezinárodních pravidel transliterace (nikoliv fonetické transkripce — viz ISO Recommendation R 9. International system for the transliteration of cyrilic characters 1. Ed. October 1955 nebo Zekalle R., 1964: *Pedobiologia*, 4: 88–91, Jena.

Obrázky a grafy kreslete černou tuší na kladívkový nebo pausovací papír v poměru 1:1 až maximálně 1:2, u taxonomických prací musí mít obrázky měřítko. Obrázky kreslete pokud možno tak, aby mohly být všechny stejným způsobem zmenšeny. Fotografie musí být ostré, kontrastní, na lesklém papíře. Obrázky sestavte do tabulí, které by bylo možno reprodukovat na šíři strany (126 mm), nebo s textem na celé zrcadlo (126 × 188 mm). Obrázky nebo obrazové tabule průběžně čísly a v rukopise vyznačte místo, kam mají být zalomeny.

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V taxonomických pracích dodržujte zásady, ustanovení a doporučení mezinárodních pravidel zoologické nomenklatury.

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