rently studied at 3 localities with practically identical procedures. However, the present study compares the ecological characteristics more thoroughly than that of Breeland et al. (1965).

Several characteristics were found to be different among the populations; survival, diapause, rate of development, feeding activity, and response to host resistance factor. Two further conclusions were reached regarding the relative sensitivity of the biotypes to changes in ecological conditions: (a) the biotype which is adapted to warmer conditions is more sensitive to temperature changes than is the biotype which is adapted to cooler conditions, and (b) the biotype which is adapted to shorter days is more sensitive to changes in photoperiodism than is the biotype which is adapted to long days. Beck and Apple (1961) studied the effect of photoperiodism on diapause of borers of different geographic sources. They reared the insect on artificial medium and under laboratory conditions. They found that southern Minnesota borers showed 98% and 78% diapause at 14.5 and 15 hr lighting, respectively, and southeast Missouri borers showed 45% and 4.5% diapause at the 2 photoperiods. Beck and Apple (1961) did not interpret their results with respect to the relative sensitivity. However, analysis of their data showed that the percentage of Minnesota borers diapausing at the shorter photoperiod (14.5 hr) was 1.3 times as great as the percentage diapausing at the longer photoperiod (15 hr), while the same ratio for the Missouri borers was 10.0. This relationship indicates that Missouri borers were much more sensitive to changes in photoperiodism. Thus, the present conclusion was supported by some laboratory results.

If these 2 conclusions are proved to be true generally, they would have great ecological significance in the prediction of behavior of introduced pests in new territories.

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Two New Mallophaga Species of the Genus *Ardeicola* Clay, 1935 (Ischnocera: Philopteridae)[1]

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ABSTRACT

Two new species of *Ardeicola, A.* ***nippon,*** from *Nipponia nippon* (Temminck), and *A.* ***emersoni*** from *Cercibis oxycerca* (Spix), are described. They are compared with related taxa, and their distinguishing characters are enumerated. *A. emersoni* n. sp. is considered to link *A. theristicus* (Pessôa & Guimarães) and *A. epiphanes* (Kellogg & Paine) with *A. meinertzhageni* Hajela.

Among the Mallophaga received for study from K. C. Emerson, U. S. National Museum, were 1 ♂ and 1 ♀ of *Ardeicola,* the former from *Cericibis oxycerca,* the latter from *Nipponia nippon.* On comparison with other *Ardeicola* from Threskiornithidae, each of the 2 individuals proved to represent a new species; furthermore the specimen from *C. oxycerca* was particularly interesting. On request, Theresa Clay, Department of Entomology, British Museum (Natural History), kindly furnished more *Ardeicola* from these ibises, thus enabling description of the new forms.

[1] This investigation was supported in part by a P. L. 480 grant (FG-In-179 (A7-ENT-28)), made by the New Delhi office of the U.S. Department of Agriculture to B. K. Tandan. Accepted for publication March 20, 1967.

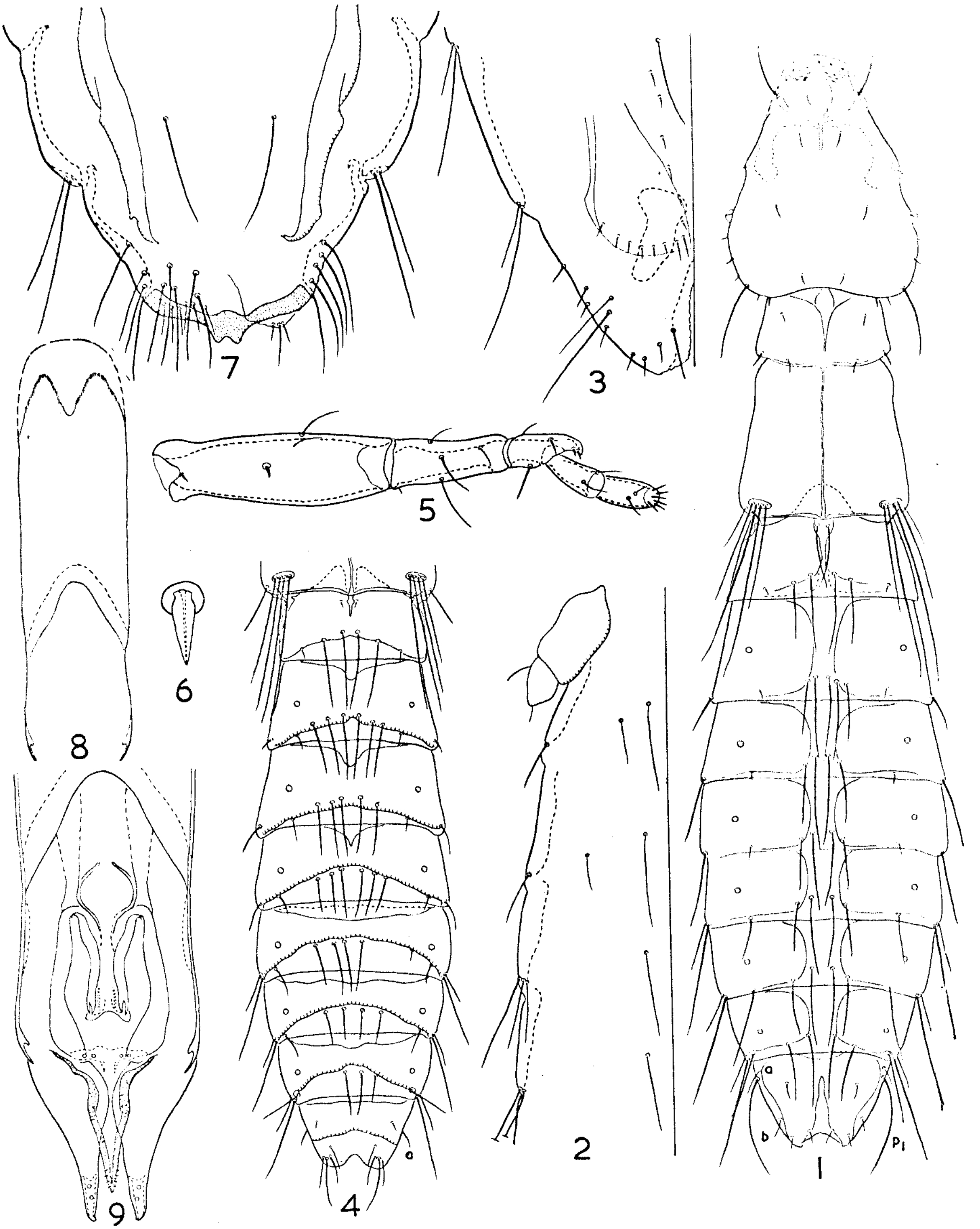

FIG. 1–3.—*Adcicola nippon* ♀. 1, dorsal view of holotype, legs and antennae not shown. 2, sterna II–V, ½ only. 3, genital region, ½ only; subgenital plate shown by unbroken line, supra-vulval sclerite shown by broken line. FIG. 4–9.—*A. emersoni* ♂. 4, dorsum of abdomen. 5, antenna. 6, stout seta on first antennal segment. 7, genital region; ventral setae on right side and anal lobe on left side not shown. 8, basal apodeme. 9, distal components of external genitalia.

Genus *Ardeicola* Clay, 1935

Ardeicola nippon, new species

Fig. 1–3

Host: *Nipponia nippon* (Temminck)

This is a feebly sclerotized species, consequently the sclerites are indistinct.

FEMALE.—General characters as in Fig. 1; measurements given in Table 1. Dorsal carina, dorsal anterior plate, and the preantennal suture as in *A. emersoni*, new species (see following). Dorsal anterior plate wider than long. Head setae thus: anterior dorsal short and those of the 2 sides relatively close; dorsal submarginal long, basally stout and slightly behind the tip of premarginal carina and posterior relative to ventral submarginal 1; anterior ventral seta 2 thin, short; seta 1 slightly thicker and moderately long; seta 3 basally stout, long; preantennal, postnodal and postemporal setae short; preconal moderately long; ocular on edge of temple, spiniform; only margin temporal seta 4 long to almost elongated, the remaining 5 spiniform, seta 6 being slightly stouter. Thorax as in Fig. 1. Outer, posterior pronotal seta spiniform and inner seta fine, short. Pterothorax wider than long; anterior pteronotal seta usually absent, otherwise minute; normal number (1,1,4) of posterior pteronotal setae in all 7 specimens available, and the longest in the group extends beyond the spiracle of III. Mesosternal setae 4 and 5 and metasternal seta 2, long.

Interpretation of abdominal segments as in *A. emersoni*, new species. Abdominal segment IX–XI posteriorly arched (Fig. 1), its tergal thickening developed as lateral plates that are continuous across anteriorly. Chaetotaxy of sterna II–V as in Fig. 2, and of the genital region as shown in Fig. 3. Subgenital plate and supra-vulval sclerites present. Abdominal chaetotaxy: Setae (Fig. 1) on terga II to IX–XI. II, 2 anterior tergocentrals (reach to or across the alveoli of and resemble the posterior tergocentrals), and 4 posterior setae; III, 4–5 posterior; IV, 4 posterior; V–VII each with 4 posterior; VIII, 1 (trichbothrium), 4, 1; IX–XI, 2 anterior (short) and 4 posterior (short, posterior tergocentral usually not on tergite). Seta **a**, (Fig. 1), 1+1 (short, anterior or posterior to p_1); b, 1+1 (short, off tergite). On II–VIII the 2 tergocentral setae are longer than tergolateral setae, when the latter are present, usually much longer on II–V and slightly longer on VI–VIII. Post-spiracular setae present on II–VII, 1+1: on II and III minute; on IV and V short; on VI and VII long, basally stout, that of VII crosses the spiracle, but never extends beyond the posterior margin, of VIII. Pleural setae, each side and total per segment as follows: II, 1, 2 (moderately long to long); III, IV, 2–4, 4–8 (moderately long to long); V, 3, 6 (2 moderately long to long, 2 long, 2 elongated); VI, VII, 3–4, 7–8 (3–4 moderately long to long, 2 long, 2 elongated); VIII, 4, 8 (4 moderately long to long, 2 long, 2 elongated); marginal and submarginal setae on terminal segment, 3–6, 7–11; seta $\mathbf{p}_1$, 1+1 (long to elongated); p_2, 1+1 (spiniform or short). Sternal setae (Fig. 2) as follows: II, III, 4 (2 sternocentrals long, 2 sternolaterals moderately long to long); IV, V, 2 (long); VI, 6 (4 long, 2 moderately long); VII, 6 (range 6–7) (2 moderately long, 4 long); VIII, 2 (range 1–2) (long); anal setae, 3+3 (4 spiniform, 2 moderately long). In addition, on III, 2–3 short setae; on V, 1 sternolateral and moderately long seta; and between VII, VIII 3–5 short setae may be present.

Material Examined.—Holotype ♀, slide no. 703 in Meinertzhagen collection (4909), British Museum (Natural History), from Japan on *Nipponia nippon*. Paratypes: 6 ♀ from the same host, having the same data, 1 of the ♀ in the collection of Dr. K. C. Emerson.

The new taxon, *A. nippon* is based on ♀ only, but as this sex shows stable characters, which distinguish the species readily from related taxa, the new taxon is justified. *A. nippon* is related to *A. clayae* Brelih, *A. indicus* Brelih and *A. ibis* (Le Souëf & Bullen), but is closest to the 2 last-mentioned species. The characters that distinguish the females of these 4 taxa are given in the form of a key:

1. On II the 2 anterior tergocentral setae minute; seta $\mathbf{p}_1$ short to moderately long; segment IX–XI relatively short............*clayae* Brelih
   No such combination of characters............ 2

2(1). On II the 2 anterior tergocentral setae reach or cross alveoli of posterior tergocentral setae and resemble the latter in proportions. Post-spiracular seta on VI, VII long; of VI reaches or fall slightly short of spiracle of VII, and of VII crosses the spiracle or reaches the posterior margin of VIII. On II–VIII the 2 tergocentral setae longer than the 2 tergolateral setae, usually much longer on II–V and slightly longer on VI–VIII. Dorsal anterior plate wider than long...................*nippon*, n. sp.
   No such combination of characters............ 3

3(2). On II the 2 anterior tergocentral setae slightly shorter and finer than posterior tergocentral setae and fall short of the latter; posterior margin of IX–XI deeply emarginate.........
   ....*indicus* Brelih
   On II the 2 anterior tergocentral setae in proportions about ½ of posterior tergocentral setae and fall short of the latter; posterior margin of IX–XI rather arched.....................
   ....*ibis* (Le Souëf & Bullen)

Ardeicola emersoni, new species

Fig. 4–12

Host: *Cercibis oxycerca* (Spix)

A well-sclerotized species. Alkali-treated specimens are brown. Sexual dimorphism is present in the antennae. There is no overlap in the lengths of the sexes.

MALE.—Head almost equally wide at the preantennal and temporal regions; measurements given in Table 1. Dorsal carina curved (Fig. 10). Dorsal anterior plate wider than long and less sclerotized centrally, its posterior margin curved considerably and interrupted medially characteristically and merges with the less-sclerotized central area. Prominent

Table 1.—Measurements of *Ardeicola nippon* and *A. emersoni* (in millimeters). Specimens mounted in Canada balsam.

		A. nippon			*A. emersoni*					
		♀ (7 spms)			♂ (8 spms)			♀ (6 spms)		
Part of body	Dimension[a]	Range	Mean	Holotype	Range	Mean	Holotype	Range	Mean	Allotype
Head	L	0.59–0.68	0.63	0.59	0.67–0.71	0.69	0.70	0.71–0.74	0.72	0.71
	B[b]	.37– .41	.39	.39	.41– .45	.43	.44	.39– .44	.41	.41
	B[c]	.44– .47	.46	.47	.41– .44	.43	.44	.47– .49	.48	.48
Prothorax	L	.16– .19	.17	.19	.20– .22	.21	.22	.18– .20	.19	.18
	B	.31– .38	.35	.35	.33– .36	.35	.36	.35– .37	.36	.37
Pterothorax	L	.36– .43	.39	.37	.39– .43	.42	.42	.41– .45	.43	.43
	B	.46– .54	.51	.46	.49– .57	.53	.54	.55– .59	.57	.55
Abdomen	L	1.59–1.91	1.78	1.59	1.62–1.86	1.78	1.83	2.12–2.18	2.15	2.14
	B	.62– .76	.69	.62	.50– .60	.55	.60	.72– .82	.76	.75
Total length		2.73–3.10	2.98	2.73	3.03–3.20	3.12	3.17	3.46–3.56	3.50	3.46
Head index		.68– .80	.72	.80	.61– .64	.62	.63	.66– .67	.66	.67
Paramere	L				.16– .18	.17	.18			

[a] L = Length, B = Breadth. [b] Preantennal width. [c] Temple width.

transverse thickenings on ventral anterior plate. Tip of gular plate joined to occipital carina, slightly posterior to the articulation of the latter with the condyle of the mandible. The first antennal segment bears a stout, peglike seta dorsally (Fig. 5, 6). Head setae thus: anterior dorsal and postnodal short to moderately long; dorsal submarginal moderately long to long, near tip of premarginal carina; preantennal and ocular spiniform, the latter close to or slightly away from the temporal margin; preconal and mandibular short; all the 6 marginal temporal spiniform, and such nature of the fourth is an important character; posttemporal short and not crossing the occipital margin; other setae short to moderately long. Endocarinae and setae named according to Clay (1951).

Pronotum continuous across segment, bearing on each side 1 minute anterior and 2 posterior setae, the outer one spiniform, and the inner short to moderately long. Pterothorax wider than long. Pteronotum medially interrupted and its normal setal count (1,1,4) present in 3 specimens only (Fig. 4); in other specimens the number in the group of 4 setae varies between 3 and 5 (total 7–10); the longest seta of the group extends beyond the spiracle of III. Mesosternal setae 4–5 and metasternal seta 2 long.

In the abdomen (Fig. 4) the first apparent segment has been interpreted as I+II, but designated as II, and the last or apparent eighth segment as composite IX–XI. The sclerotized two-thirds of the terminal segment is interpreted as tergum IX–X, and the unsclerotized posterior one-third as tergum XI. Outer corners of anal lobes project slightly beyond tergum XI. Sternal thickenings II–VII developed as lateral, elongated plates, each on VII being continuous with the narrow subgenital plate of its side. Terminal sternum thickened posteriorly and produced medially characteristically (Fig. 7); the posterior thickened edge forms the margin of the genital opening which, therefore, is ventral and terminal. External genitalia as shown in Fig. 8, 9. Abdominal chaetotaxy: Tergal setae as shown in Fig. 4. II, 2 anterior tergocentrals (minute to short) and 4–6 posterior setae; III, 6–7; IV–VI, 5–6; VII, 4–6; VIII, 1, 2–4, 1 (trichbothrium off tergite); IX+X, 2 (minute to short); XI, 2 anterior (moderately long to long) and 3+3 posterior setae (moderately long to long); the position of those on XI may vary, relative to each other. Seta **a**, 1+0+1, short, fine, laterally placed near the middle of IX–XI; **b**, not identifiable. Post-spiracular seta present on II–VII, 1+1; on II–V short; on VI short to moderately long; on VII moderately long to long. On V the outer seta of one or both sides is slightly shorter and finer; the outer seta of 1 side (VI–VIII) or both sides (VI) may be much shorter and finer. Pleural setae, each side and total per segment as follows: II, 1, 2 (spiniform); III, 2, 4 (2 spiniform, 2 short); IV, 2, 4 (short to moderately long); V, 3, 6 (4 moderately long, 2 long); VI–VIII, 4, 8 (4 moderately long to long, 4 elongated); marginal and submarginal setae on terminal segment, 4–6, 9–12 (long). Setae homologous with $\mathbf{p}_1$ and $\mathbf{p}_2$ of other species not identifiable. Sternal setae as follows: II, 4 (2 sternocentrals elongated, 2 sternolaterals short to moderately long); III–V, 2 (elongated); VI, 4 (2 sternolaterals short to moderately long, 2 sternocentrals elongated); VII, 6 (2 minute to short, 4 long), in addition sternum VII may have 1–3 minute to short setae; VIII, 2 (long). Anal setae, 3+3 (2 spiniform, 4 short) all marginal in position. Chaetotaxy of genital region as in Fig. 7.

FEMALE.—General characters of head and thorax as in male, but (i) measurements are slightly different (Table 1), (ii) head is wider across the temples than at the preantennal region, (iii) gular plate is normal anteriorly, (iv) same setae are shorter and finer, postemporal being minute, and (v) the antenna is filiform. Thoracic setal count as in male, but inner, posterior pronotal seta is minute. Interpretation of the first 7 apparent abdominal segments as in male, while the terminal or apparent eighth segment has been interpreted as composite IX–XI; it is emarginate posteriorly. Tergal thickening IX–XI as lateral plates, characteristically pigmented (Fig. 11). Sternal thickenings II–VII as in male; on VII each sternal

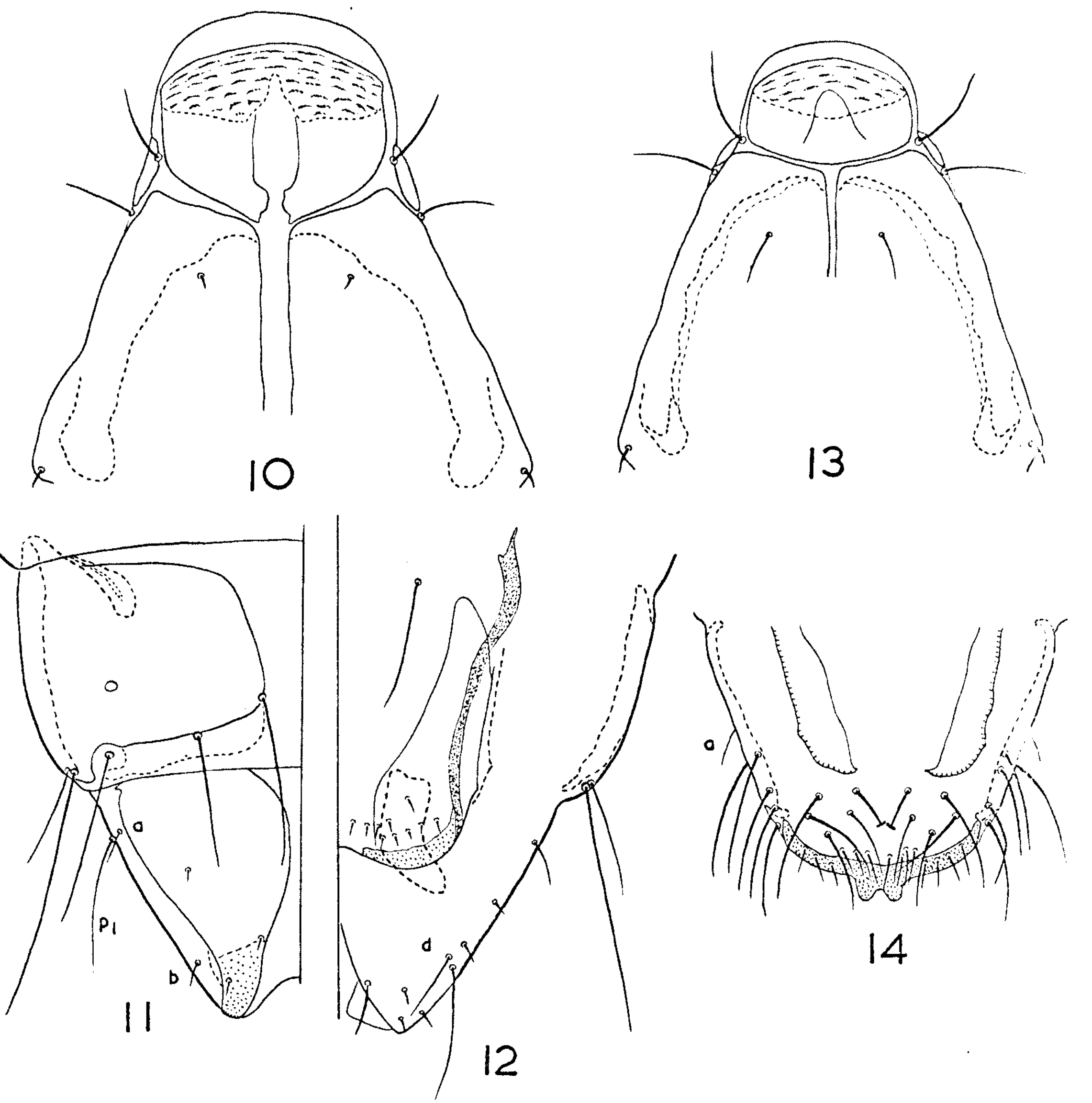

FIG. 10–12.—*Ardeicola emersoni* ♀. 10, Preantennal region of head. 11, terminal abdominal segments, dorsal view. 12, terminal abdominal segments, ventral view. FIG. 13, 14. *A. theristicus* (from *Theristicus c. caudatus*). 13, preantennal region of head, ♀. 14, genital region, ♂.

thickening continuous with the subgenital plate on the same side. Genital region as in Fig. 12; post-vulval sclerites short and bent. Abdominal chaetotaxy: Tergal setae; disposition as in male; II, 2 anterior tergocentrals (minute) and 4–6 posterior setae; III, 6–7; IV, 6; V–VII, 4–6; VIII, 1, 2–4, 1 (trichbothrium on secondary sclerotization); IX–XI, 2 anterior setae (minute to short) and 4 posterior setae (short), position of the setae showing variation. Setae **a** and **b**, 1+1 (short and fine). Seta **a** is normally submarginal, anterior or posterior to $\mathbf{p}_1$, otherwise it may be present even on tergite IX–XI; in 1 specimen it occurs near the anterior tergal seta of its side, on IX–XI. Post-spiracular seta on II–VII, 1+1; on II–IV minute; on V–VII short. The outer seta of 1 side (V–VII) or of both sides (V and VII) may be slightly or much shorter and finer; on VIII also this condition obtains, when tergolateral setae, besides the 2 tergocentrals, are present. Pleural setae, each side and total per segment as follows: II, 1, 2 (spiniform); III, 2, 4 (2 spiniform, 2 moderately long to long); IV, 2, 4 (2 moderately long, 2 long); V, 3, 6 (4 long, 2 elongated); VI–VIII, 4, 8 (as in male); seta $\mathbf{p}_1$, 1+1 (moderately long to long); $\mathbf{p}_2$, 1+1 (spiniform, tends to be long); marginal and submarginal setae, 2–5, 6–10 (spiniform or short). Sternal setae: same numbers as in male except that on VI and VII the setae may be longer. Seta **d**, 2+2 (2 short to moderately long, 2 long); anal setae, 3+3 (2 moderately long, stout, 4 spiniform). Chaetotaxy of genital region as in Fig. 12; 16–22 minute setae beset the vulval margin (4–6 medial, 6–11 on each side).

Material Examined.—Holotype ♂ and allotype ♀, slide no. 704, British Museum (Natural History) collection, from near Lethem, Rupunini, British Guiana (now Guyana) on *Cercibis oxycerca*, 16.2.1961 (T. Clay collected, no. 142). Paratypes, 7 ♂ (1 dissected) and 6 ♀ having the same data, 1 of the ♂ in the collection of K. C. Emerson. The species is named to honor Dr. K. C. Emerson of the U.S. National Museum.

A. emersoni resembles 3 species, *A. theristicus* (Pessôa & Guimarães), *A. epiphanes* (Kellogg & Paine), and *A. meinertzhageni* Hajela. It resembles the 2 first-mentioned taxa in both the sexes in the terminalia and external genitalia; further, in the male, in having a stout dorsal seta on the first antennal segment. *A. emersoni* can be readily distinguished from these by the shape of the dorsal carina, preantennal suture, and the dorsal anterior plate (compare Fig. 10 and 13). It resembles *A. meinertzhageni* only in the characters of the preantennal region of the head, and can be distinguished from the latter species in both sexes by the terminalia and external genitalia.

A. emersoni is considered an annectant species, linking *A. theristicus* and *A. epiphanes* with *A. meinertzhageni*. Phylogenetically it is closer to *A. epiphanes* and *A. theristicus*, and the shape of the thickening of the margin of the genital opening (compare Fig. 7 and 14) indicates it to be closer to *theristicus*.

ACKNOWLEDGMENTS

We are most grateful to Dr. Theresa Clay and Dr. K. C. Emerson for kindly lending the material described in this paper and for much valuable help.

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Effects of Ionizing Radiation on the European Chafer, the Plum Curculio, and the Large Milkweed Bug[1]

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ABSTRACT

This study evaluated the effects of cobalt-60 radiation on the longevity of 3 insect species, the European chafer, *Amphimallon majalis* (Razoumowsky); the plum curculio, *Conotrachelus nenuphar* (Herbst); and the large milkweed bug, *Oncopeltus fasciatus* (Dallas). The 2 first-mentioned species are of economic importance in New York State and the Northeast.

In the initial tests with irradiation, high natural mortality occurred in laboratory tests with European chafer adults. This mortality could be reduced by crowding beetles in test containers or supplying a sugar-water solution. Significant irradiation mortality occurred after 2 days' exposure at doses ranging from 25 to 125 kr.

With the plum curculio, irradiation of adults at a dose of 500 kr resulted in immediate kill. Curculios exposed to 100 kr did not survive more than 4 days. A dose of 2 kr to adult curculios resulted in an 87% decrease in F_1 adult progeny, with a 31% decrease in F_2 progeny, as compared with untreated checks. An LT_{50} value of 6.8 days was obtained for female curculios at 50 kr; at the 10-kr dose the LT_{50} value was in excess of 10 days. The LT_{50} values for male curculios were 5.8 and 10.3 days, respectively, at 50- and 10-kr dosages.

Adult milkweed bugs were more tolerant to cobalt-60 radiation than plum curculio. An LT_{50} value of 12.5 days was obtained for female large milkweed bugs at a dose of 50 kr. At 10 kr, the LT_{50} value was 28.0 days. LT_{50} values of 10.2 and 29.5 days were obtained for male large milkweed bugs at doses of 50 and 10 kr, respectively. At doses of 10–50 kr, no significant egg hatch was obtained. Hatch of eggs from 1-kr-treated females was reduced 2 days after treatments. Normal hatch was recorded at 3 days and total number of eggs did not differ from the checks. The oviposition rate of adult females was evaluated also at doses of 25–200 kr. In studies with 1- and 4-day-old eggs at a dose of 5 kr, 55% hatch of 4-day eggs was obtained. None of the 1-day eggs hatched at this dose. Eggs of 0-, 1-, and 4-day age were submitted to excessively high doses of 100 and 500 kr. Only 1% hatch was obtained with 4-day-old eggs at the 100-kr level.

Within the past few years, numerous new techniques for insect control have attained wide recognition. One of these approaches is sterilization, accomplished by either chemosterilants or ionizing radiation. In the present study, ionizing radiation was used to determine its effect on longevity, fecundity, feeding rate, oviposition, and egg hatch.

The success of the sterile-male technique, as demonstrated with the screwworm, *Cochliomyia hominivorax* (Coquerel), by Bushland and Hopkins (1951, 1953), Baumhover et al. (1955), and Knipling (1955), has led to its adoption for other species. Preliminary studies with ionizing radiation were initiated at the New York State Agricultural Experiment Station at Geneva (New York) in 1965 with 3 insect species. These were: the European chafer, *Amphimallon majalis* (Razoumowsky); the plum curculio, *Conotrachelus nenuphar* (Herbst); and the large milkweed bug, *Oncopeltus fasciatus* (Dallas).

The European chafer is an introduced species

[1] Approved by the Director of the New York State Agricultural Experiment Station for publication as Journal Paper no. 1561. Accepted for publication February 16, 1967.
[2] This research was supported in part by a National Institutes of Health Grant, EF-00171-08.