mandibulären Muskels in der Kopfkapsel. Bei der Bildung des Pupariums kommt die Junglarve während der Umbildung des Muskels wieder frei im Haemocoel zu liegen.

Später sind die Junglarven im Puparium in einer Höhlung zu finden, die sich zwischen Abdomen und den hierüber gefalteten Flügeln, Antennen und Beinen befindet, also eigentlich ausserhalb des zukünftigen Falters. Es befindet sich dort auch eine Luftblase, die in Verbindung mit den ersten abdominalen Stigmen steht, die ebenfalls in diesem Raum ihre Austrittsstellen haben. Öfters sind die Maden hier beobachtet worden, während sie mit ihren terminalen Stigmen die Luftblase berührten.

Eine Bedeutung dieser Höhle mit Luftblase für die Respiration des Pupariums wird angenommen.

Utrecht, Weerdsingel O.Z. 68bis.

Animals attacking metals

by

J. PACLT

In 1697, the date of publication of the peculiar memoir "De Vermiculis plumbum depascentibus" [1], a beginning was made with the literature dealing with the Pests of Metals, or Metallophagy of Animals. Like certain marine invertebrates that bore into rock, often with great efficiency, the metallophagous organisms raise some interesting problems of feeding possibilities. When we examine the phenomenon which, of course, received the epithet of curiosity by the ancient men of science, at least two elementary questions appear to be of importance to us:

1. Does a notable difference exist in the hardness between the metals attacked by a certain animal on the one hand, and its normal food on the other hand ?
2. Can animals be poisoned when absorbing metals ?

As regards the first question, let us compare the values recorded in table I, from which we learn that soft metals can generally be cut by the insect mandible just as easily as various woods.

Table I

Material considered	Hardness according to BRINELL (kg/mm^2)
Lead	4
Tin	5
Aluminium	16
Copper	35
Zinc	35
Woods :	
Pine	1.3 to 7.2
(Bongosi)	13 to 90
Poplar	0.8 to 3.4

The other questions as to whether peroral absorption of metals like lead and copper may poison the animal organism must be answered affirmatively. To-day, these poisonings are called plumbism, cuprism, etc., in human medicine. Following old writers (GMELIN 1806) there were in use numerous terms to designate the modern plumbism: belland or milreach of English authors; colique de plomb, colique metallique, etc., in French literature; Bleikolik, Hüttenkatze, etc., in German literature; and morbus metallicus, m. saturninus, oenagra, rhachialgia metallica, colica saturnina, colica spasmodica plumbea, etc., in Latin texts.

Unfortunately, little or nothing is known at present about the effects of various quantities of lead and other metallic elements on the organism of small animals, especially invertebrates. The only symptom to be observed occasionally in insect larvae which had absorbed metal, is production of "diarrhoetic" faeces (*Phalera*, e.g.). Effects of metal absorption on the organism may or may not be the same in different animal species and in individuals of different age.

In principle, animals may attack the metal in two different ways. They either damage the metal without permitting it to enter in the tract (as in rodents) or ingest it at the same time. The latter process is termed "metallophagy" and may be observed primarily among insects.

Some rodents may be considered, perhaps, as chief destructors of various metallic constructions on the ground. Common rats, surmulots and other mice bite through leaden water-pipes [2, 3], copper telephone wires, etc. Injury caused by birds may be observed sometimes in lead-covered aerial cables; remnants and impressions of birds' beaks in the lead covering have revealed this interesting fact [4, 5]. For an explanation only one theory seems to be plausible. The remnants or impressions give evidence of a sudden squall or another factor throwing the bird violently its bill against the place of damage.

It rarely happens that the injury to metal materials is due to a chemical action of some secretions of the animal. It is assumed, at least, that the corrosion of lead-covered submarine cabels referred to from Rio de Janeiro has been caused by some chemical agent from the body of *Chiton*, a mollusc occurring abundantly on the damaged pipes [2]. Other marine organisms seem not to injure metal at all and in many cases are poisoned when coming into contact with such materials [6].

The insects represent quite an important group of truly metallophagous animals. There are some different motives for the metallophagy. Being guided by its biological instincts (search for food, place of safety, etc.), the insect tries to remove all material obstacles. For instance, the predatory larvae of Asilidae have damaged the inside of a leaden tube while being held in captivity [7]. There is evidence, however, that insects may attack metal in order to appease hunger. The larvae of certain moths and butterflies (*Phalera bucephala, Arctia caja, Pieris brassicae, Cossus cossus*) devour metal foils when without food [8]. Some larvae, when kept without food, could damage much thicker material. The larvae of *Ephestia kühniella* have thus eaten through a small leaden plate in an experiment [22].

With the exception of *Cossus cossus* (L.), *Xyleutes boisduvali* Rothsch., *Cerura* sp., and an undetermined "microlepidopteron" (all Lepidoptera) [5, 7, 40], all insects found to damage metal outside the laboratory belong either to the Hymenoptera, or to the Coleoptera. The former include a historically interesting species, *Sirex juvencus* (L.), which attacked leaden cannon-balls in the campaign of the French in the Crimea [9, 11]. In this case the destruction was caused by larvae of that Hymenopteron, and a number of additional injuries to leaden materials due to the larvae of *Sirex gigas* (L.) and *Sirex juvencus* (L.) respectively, are referred to in the literature [12—15, 41]. In China, the adults of a wasp (*Xylocopa*) attacked lead-covered cabels [2, 7].

The larvae and imagoes of beetles (Coleoptera) are, no doubt, the most numerous destructors of metal among the insects. Some of these damage such materials as leaden coverings [16—18], clichés [19], zinc matrices [20], lead and tin ingredients [21], as well as lead-covered aerial cables [5, 7, 22, 23]. The species shown to be metallophagous occasionally in nature are enumerated in table II.

Further species of beetles of the families Apatidae, Buprestidae, Cerambycidae, Curculionidae and Ipidae are known to have damaged metal in the laboratory [5, 7, 26].

Animal injury to metal construction and stored products of this type amounts annually to sums which cannot be precisely calculated but which are not to be undervalued. There does not exist a universal remedy, but in each case a special method of control must be considered.

Table II

Family and species	Metal	Reference	Note
ANOBIIDAE			
Anobium domesticum (Fourcr.)	Pb	[24]	
ANTHRIBIDAE			
*Eceloneru*s sp.	Pb	[25]	Australia
APATIDAE			
Apate capucina (L.)	Pb	[19]	
A. cylindrica (Gerst.) , . .	Pb	[7]	Australia
Bostrychopsis jesuita (F.) . .	Pb	[25]	Australia
Micrapate brasiliensis Lesne .	Pb	[5]	Uruguay
Schistocerus bimaculatus Oliv. .	Pb	[5]	Greece
Scobicia declivis Lec.	Pb	[26]	U.S.A.
Sinoxylon 6-dentatum Oliv. . .	Pb	[5, 27—29, 39]	Italy, Iberia,. Greece
? *S. ruficorne* Fhs.	Pb	[30]	Africa
Xylopertha sp.	Pb	[25]	Australia
Xylothrips sp.	Pb	[31]	Australia
CERAMBYCIDAE			
Callidium sp.	Pb	[26, 32]	
Eburia distincta Hald. . . .	Pb	[33]	U.S.A.
Hylotrupes bajulus (L.) . . .	Pb, Zn	[18, 20]	Italy
Megaderus stigma (L.) . . .	Pb	[34, 35]	Brazil
Monochamus sutor (L.) . . .	Pb	[36]	
Rhagium bifasciatum F. . . .	Pb	[5]	Germany
DERMESTIDAE			
Dermestes peruvianus Casteln. .	Pb, Sn	[21]	Germany
D. lardarius L.	Fb, Sn	[21]	Germany
D. vulpinus F.	Pb	[38]	
SCARABAEIDAE			
Cetoniinae gen. sp.	Pb	[19]	

References

[1] NEBEL, M., 1697, *Ephemer. Acad. Caesar. Natur. Curios.*, III, 5 + 6 : 220.
[2] HESSE, R., 1925, *Biol. Zbl.*, 45 : 19.

[3] KLEINER, O., 1931, *Kosmos* (Stuttgart), 28 : 395.
[4] WINNING, E. VON, 1933, *Anz. Schädlingsk.*, 9 : 55.
[5] HORN, W., 1937, *Arb. physiol. ang. Entomol.*, 4 : 265.
[6] KÜHL, H., 1950, *Zool. Anz.*, 145, Suppl. (Neue Ergebnisse und Probleme): 461.
[7] HORN, W., 1933, *Arch. Post Telegr.*, 61 : 165.
[8] PACLT, J. and SCHWARZ, R., 1954, *Biol. Zbl.*, 73 : 503.
[9] BRÊME, F. DE, 1844, *Ann. Soc. entomol. France,* s. 2, 2. Bull.: 20.
[10] VAILLANT, 1857, *C. R. Acad. Sci. Paris*, 45 : 360.
[11] KOLLAR, V., 1857, *Verh. Wien. zool. bot. Ver.*, 7 : 153.
[12] SELLS, W., 1839, *Trans. entomol. Soc. London*, 2, Proc.: 83.
[13] KOLLAR, V., 1854, *Verh. Wien. zool. bot. Ver.*, 4, *Sitz.-Ber.*: 114.
[14] HAGEN, H. A., 1854, *Verh. Wien. zool. bot. Ver.*, 4, *Sitz.-Ber.*: 113.
[15] DUMÉRIL, A. M. C., 1857, *C.R. Acad. Sci. Paris*, 45 : 361; 1857, *Rev. Mag. Zool.*, s. 2, 9 (with some observations by GUÉRIN); 1858, *Ann. Soc. entomol. France,* s. 3, 6, *Bull.*: 147.
[16] DESMAREST, E., 1857, *Ann. Soc. entomol. France*, s. 3, 5, *Bull.*: 101.
[17] EMY, 1833, *Ann. Soc. entomol. France*, 2, *Bull.*: 76.
[18] TROSCHEL, F. H., 1859, *Verh. naturh. Ver. preuss. Rheinl.*, 16, *Sitz.-Ber.*: 117.
[19] DESMAREST, E., 1844, *Ann. Soc. entomol. France*, s. 2, 2, *Bull.*: 24 & 32; 1851, *Ibid.*, s. 2, 9, *Bull.*: 16.
[20] CORMIO, R., 1949, *Riv. Catasto Serv. tecn. erar.,* n.s., 4 : 138.
[21] BAUER, O., and VOLLENBRUCK, O., 1930, *Z. Metallk.*, 22 : 230 ; 1931, *Ibid.*, 23 : 117.
[22] HORN, W., 1934, *Arb. physiol. ang. Entomol.,* 1 : 291.
[23] HORN, W., 1939, *Umschau* (Frankfurt a.M.), 43 : 102.
[24] WHITE, A., 1853, *Zoologist*, 11 : 3781; 1851, *Proc. Linn. Soc. London*, 2 : 153.
[25] HESKETH, J., 1904, *Trans. int. electr. Congr.*, 3 : 438.
[26] BURKE, H. E., HARTMAN, R. D. and SNYDER, T. E., 1922, *U.S. Dept. Agr. Bull.*, 1107.
[27] RESPIGHI, L., 1920, *Riv. tecn. bim., Telegr. Telef.*, 1 : 116.
[28] GRANDI, G., 1930, *Boll. Soc. entomol. Ital.*, 62 : 17.
[29] AGUILAR-AMAT, J. B. DE, 1930, *Bol. Inst. catal. Hist. natur.,* (2), 10 : 58.
[30] LOUNSBURY, C., 1915, *Bull. entomol. Res.*, 6 : 201.
[31] FROGGATT, W. W., 1917, *Agr. Gaz. N. S. Wales*, 28 : 814.
[32] AUDOUIN, J. V., 1833, *Ann. Soc. entomol. France*, 2, *Bull.*: 76.
[33] SNYDER, T. E., 1930, *J. Wash. Acad. Sci.*, 10 : 580.
[34] MOREIRA, C., 1930, *Bol. Inst. Biol. Def. Agr.*, (1930), No. 8.
[35] RENDELL, E. J. P., 1930, *Proc. entomol. Soc. Wash.*, 32 : 104.
[36] WHITE, A., 1850, *Trans. entomol. Soc. London,* s. 2, 1, *Proc.*: 34.
[37] SCHIRCH, P. F., 1929, *Bol. Mus. nac. Rio de Jan.*, 5 : 97.
[38] GABEL, H. H., 1955, *Z. angew. Entom.,* 37 : 153.
[39] BAETA NEVES, C. M., 1955, *Bol. Soc. portug. Ci. natur.*, s. 2, 5 : 49.
[40] LAPKAMP, K. & KÖRNER, L., 1954, *Fernmeldetechn. Z.* (Braunschweig), 7 : 465.
[41] POSTNER, M., 1955, *Anz. Schädlingsk.,* 28 : 103 (with some additional references).

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Waardering van morfologische kenmerken. In de *Mitt. Hamburg. Zool. Mus. Inst.* 53 : 75—108, december 1955, verscheen een artikel van W. WAGNER, getiteld :

Die Bewertung morphologischer Merkmale in den interen taxonomischen Kategorien, aufgezeigt an Beispielen aus der Taxonomie der Zikaden.

Dit artikel zet op zeer duidelijke wijze uiteen, welke mogelijkheden en welke moeilijkheden de moderne taxonomische methoden bieden.

Ik kan het ten zeerste ter lezing aanbevelen aan een ieder, die zich oriënteren wil over het afwegen van de waarde van naverwante taxa.

Jammer is, dat door de aard der behandelde stof de moeilijkheden met parthenogenetische vormen niet ter sprake komen. — G. KRUSEMAN.