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LARINUS PLANUS (F.) IN NORTH AMERICA (COLEOPTERA: CURCULIONIDAE: CLEONINAE) AND COMMENTS ON BIOLOGICAL CONTROL OF CANADA THISTLE

A. G. WHEELER, JR. AND D. R. WHITEHEAD

(AGW) Bureau of Plant Industry, Pennsylvania Department of Agriculture, Harrisburg, Pennsylvania 17110; (DRW) Systematic Entomology Laboratory, IIBIII, Agricultural Research Service, USDA, % U.S. National Museum, NHB 168, Washington, D.C. 20560.

Abstract.—*Larinus planus* (F.), a palearctic weevil known previously in North America from a single locality in Maryland, is well established in the northeastern U.S.: Pennsylvania (35 counties), Maryland (6), Ohio (3), and New York (2). The earliest available records, from Ohio (1968) and New York (1969), suggest that the weevil has been present for some time as an accidental immigrant. *L. planus* thus extends a growing list of natural enemies of the alien weed, Canada thistle, *Cirsium arvense* (L.) Scop., and its biocontrol potential against this weed is briefly discussed. Because it superficially resembles the deliberately introduced thistle weevil *Rhinocyllus conicus* (Froelich), we give characters to distinguish *L. planus* from this weevil and from other North American Cleoninae.

Larinus planus (F.) (= *carlinae* Olivier), a cleonine weevil of the tribe Lixini, belongs to a large genus (180+ species) well represented in the Palearctic Region. *Larinus* spp. typically develop in flower heads of composites of the tribe Cardueae (= Cynareae) (Zwölfer et al., 1971; Ter-Minasyan, 1978; Zwölfer and Harris, 1984). The rostrum of females in this genus is either curved for depositing eggs through a tunnel into the interior of a bud, or conical for pushing eggs through florets from above (Zwölfer and Harris, 1984).

Larinus planus ranges throughout much of Europe and central Asia (Hoffmann, 1954; Ter-Minasyan, 1978). Larvae of this species, described as "endophytic in flower heads and buds" of their hosts (Zwölfer, 1965), destroy ovarioles and other floral structures. Adults feed on host foliage without causing conspicuous damage (Batra et al., 1981). This apparently univoltine weevil overwinters in the adult stage and develops mainly in *Carduus* and *Cirsium* spp. having small capitula, especially Canada thistle, *Cirsium arvense* (L.) Scop., although local European populations may use *Centaurea* spp. as hosts (Zwölfer et al., 1971; Morris, 1983).

The only published Western Hemisphere record of *L. planus* (White, 1972; O'Brien and Wibmer, 1982) was a specimen collected from *Cirsium* sp. at Maugansville, Maryland in 1971. Our survey work in 1984 shows that this species is widespread in much of Pennsylvania and northern Maryland, and it occurs also in New York and Ohio. Its distribution partly overlaps the eastern range of

Rhinocyllus conicus (Froelich), a related palearctic weevil released for biocontrol of *Carduus* and *Silybum* thistles (Zwölfer and Harris, 1984). Allen (1975) commented on the similarity of these sympatric species of the British fauna: "*L. planus* invites comparison with another lixine similar in size, coloration, habits, distribution, and incidence, namely *Rhinocyllus conicus* Fröl." Here, we comment on the potential of *L. planus* to help control adventive thistles and contrast its apparent host preferences with those of *R. conicus*, illustrate morphological differences between these two weevil species and give characters allowing them to be distinguished from other North American cleonines, and provide a key to genera of native and immigrant Cleoninae occurring in America north of Mexico.

Materials and Methods

Collection of *L. planus* on Canada thistle at Philadelphia on 11 July 1984 prompted a survey to determine the weevil's distribution in Pennsylvania. From mid-July to late August colonies of the plant were sampled with a standard sweep net, or stems were tapped over a net or small tray to obtain adults. The eastern counties were surveyed most extensively, with emphasis on delimiting the area of sympatry with *R. conicus* in the southcentral region. Musk or nodding thistle, *Carduus nutans* L., and plumeless thistle, *C. acanthoides* L., also were sampled, as were other *Cirsium* and *Centaurea* species. Additional collections of *L. planus* were made from thistles in Maryland, New York, and Ohio; surveys in Berkeley Co., West Virginia were negative for *L. planus* but yielded specimens of *R. conicus* at several localities.

Records given for *L. planus* include specimens other than those taken in our 1984 surveys. Sources for unpublished records are the insect collections of Cornell University, Ithaca, New York (CUIC), National Museum of Natural History, Washington, D.C. (NMNH), Pennsylvania Department of Agriculture, Harrisburg (PDAH), and Charles W. O'Brien, Tallahassee, Florida (CWOB).

North American Distribution

The known North American distribution of *L. planus* now includes Pennsylvania (35 counties), Maryland (6), Ohio (3), and New York (2) (Fig. 1). All Maryland and Pennsylvania records prior to our survey and all records from New York and Ohio are listed below. Unless stated otherwise, all collections were from Canada thistle. Localities for the 1984 Maryland and Pennsylvania collections are mapped (see Fig. 1); more precise data are available from the authors.

MARYLAND. *Washington Co.*: Maugansville, 15 June 1971, on *Cirsium* sp., R. E. & J. White (NMNH). NEW YORK. *Monroe Co.*: Scottsville, 23 Aug. 1973, on *Carduus nutans*, R. H. Ward (NMNH). *Tompkins Co.*: Taughannock Falls, April 1969, Lenczy (NMNH); N. Lansing, 2 May 1983, N. M. Downie (CWOB); Ithaca, 9 Sept. 1984, E. R. Hoebeke (CUIC). OHIO. *Stark Co.*: nr. Alliance, 10 Aug. 1984, K. Valley (PDAH). *Tuscarawas Co.*: 2 mi. n. Dover, 17 Aug. 1968, M. Druckenbrod (NMNH). *Wayne Co.*: Wooster, 15 Dec. 1980, on Norway spruce (NMNH). PENNSYLVANIA. *Cumberland Co.*: rt. 11 nr. Carlisle, 17 April 1974, on *Pinus virginiana*, T. J. Henry & A. G. Wheeler, Jr. (PDAH). *Dauphin Co.*: Paxtang, 13 July 1971, G. B. Sleesman (PDAH); Middletown, 14 May 1979, G. Laudermilch (PDAH, NMNH).

The Dover, Ohio and Taughannock Falls, New York records predate White's (1972) record from Maryland. These earlier records and the widespread occurrence

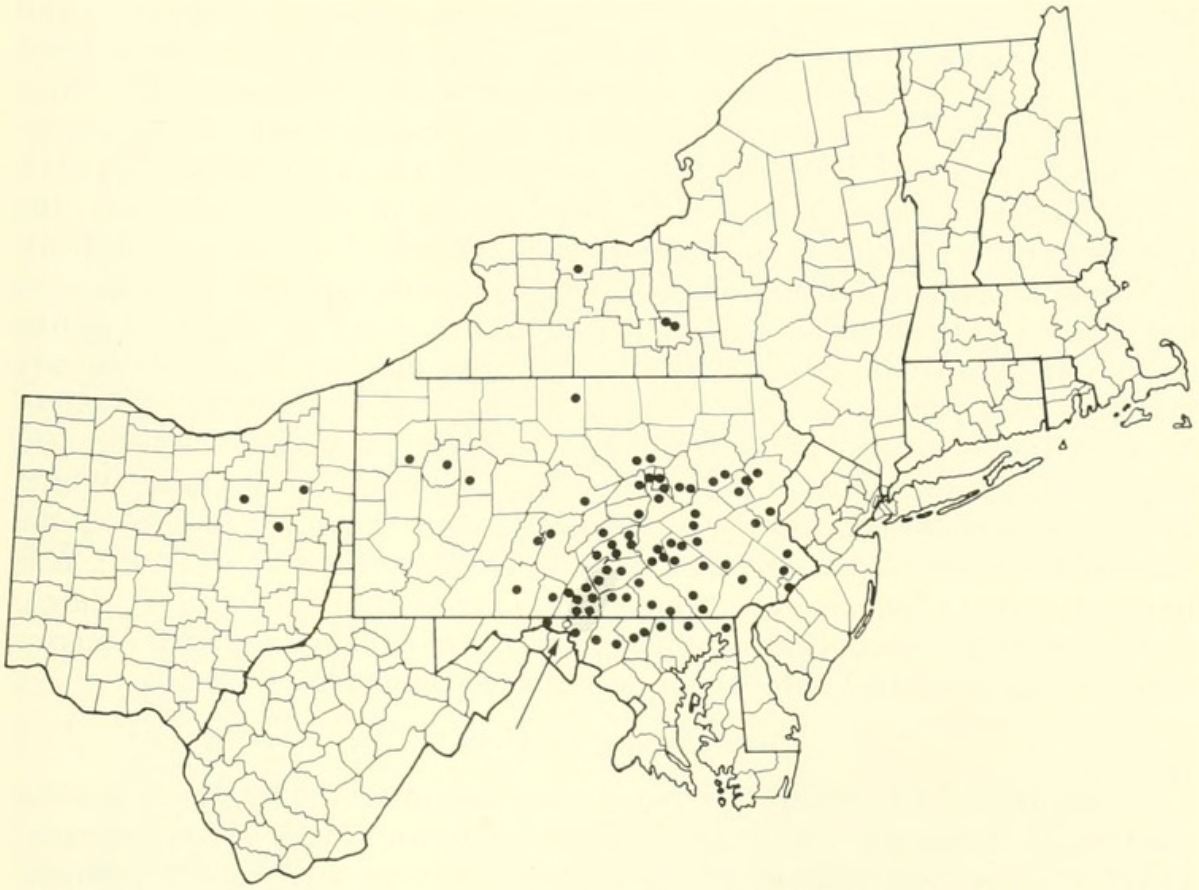


Fig. 1. Known distribution of *Larinus planus* in North America. The open circle (arrow) represents the original detection site in Washington Co., Maryland (White, 1972); closed circles are new records. Stippling indicates the observed area of sympatry with *Rhinocyllus conicus*.

in Pennsylvania indicate that *L. planus* has been well established in eastern North America for some time.

Host Plants

Of the 75 collections of *L. planus* made from Maryland, New York, Ohio, and Pennsylvania in 1984, all but four were from Canada thistle. Our survey was based only on adults, but from the consistent occurrence of the weevil on this plant, we think that this thistle serves as the principal host in eastern U.S.

We also collected adults of *L. planus* twice on musk thistle and twice on plumeless thistle. At two of these sites, however, the weevil was more common in nearby colonies of Canada thistle. Whether *Carduus* spp. and other thistles having large capitula serve as true hosts in eastern North America needs verification.

Near Hagerstown, Maryland and Greencastle, Pennsylvania, we found *L. planus* coexisting on *Carduus* thistles with *R. conicus*, a similar-appearing cleonine weevil released and established at these locales (Batra, 1980). We note that although *R. conicus* was not encountered on Canada thistle during our surveys, in Montana under high densities on musk thistle it has shifted to this alien weed and to one native *Cirsium* species (Rees, 1977).

Immigrant Status

An overlooked immigrant, *L. planus* now can be included among natural enemies of Canada thistle in North America. Among Coleoptera, these species include

two accidental immigrants—another cleonine weevil, *Cleonis piger* (Scopoli), and the chrysomelid *Cassida rubiginosa* Muller—and a weevil, *Ceutorhynchus litura* (F.), which has been released and subsequently established. The chrysomelid *Altica carduorum* Guérin-Méneville, released in Canada and the United States, apparently has not become established (Maw, 1976; Batra et al., 1981; Peschken, 1981).

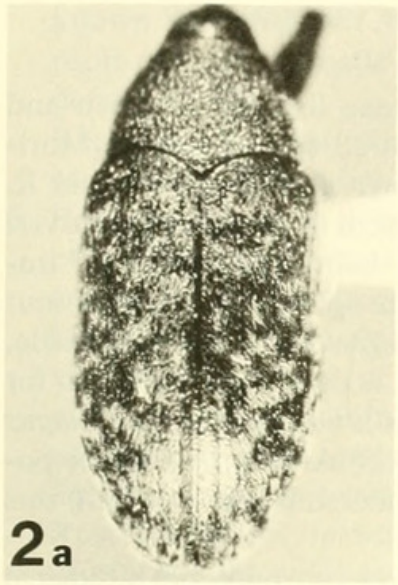
Larinus planus was evaluated for possible release in North America by the Commonwealth Institute of Biological Control, Canada Department of Agriculture (now Agriculture Canada), and U.S. Department of Agriculture, and in 1962 and 1964 small numbers of adults were shipped to Canada for additional testing but not released (Batra et al., 1981). At that time, however, *L. planus* already may have been present in North America. Although the first published record of *L. planus* (as *L. carlinae*) in the Western Hemisphere was from a Maryland field in which *Altica carduorum* had been released to suppress Canada thistle (White, 1972), two unpublished records of the weevil (New York, Ohio) predate the Maryland releases of *A. carduorum* in 1970–1971 (see Batra et al., 1981). It is improbable that *L. planus* was a contaminant in releases of *R. conicus* (P. Harris, in litt.). We therefore conclude that the occurrence of *L. planus* in North America represents an accidental introduction with man's commerce.

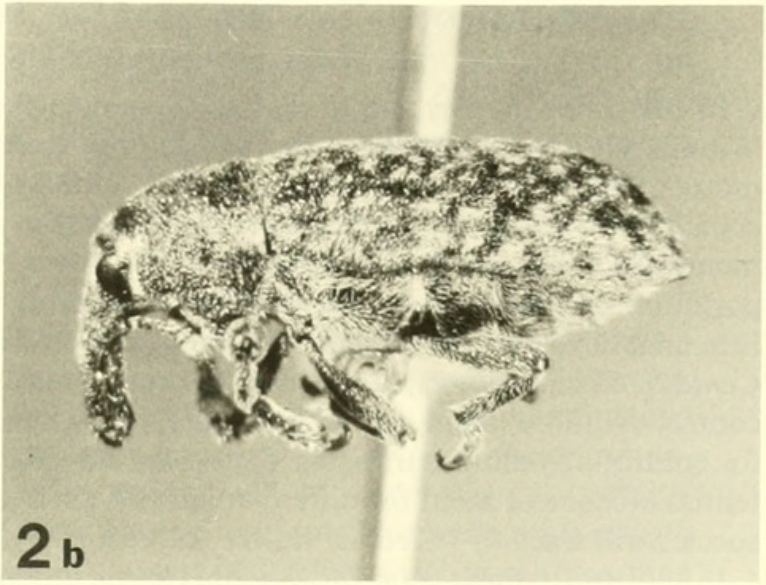
Biocontrol Potential

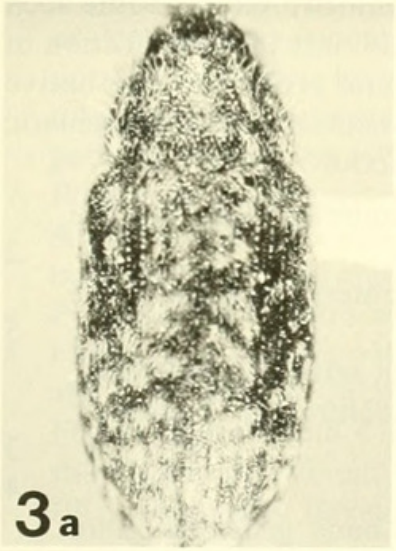
Canada thistle, a Eurasian native, is naturalized in southern Canada and the northern United States. This long-day plant, intolerant of high summer temperatures, is uncommon south of 37°N and thrives between 40° and 49°N latitude. *Cirsium arvense* is a perennial, functionally dioecious herb that spreads mainly by deepseated, horizontal, creeping roots that give rise to aerial shoots (Detmers, 1927; Moore, 1975; Hill, 1983). The continual growth of roots, year after year, allows plants to survive indefinitely (Moore, 1975). This insect-pollinated plant also is dispersed by wind-blown seeds, but seed production is limited and depends primarily on whether male and female plants are sufficiently near to effect pollination (Detmers, 1927).

Two characteristics of Canada thistle—dioeciousness and propensity for vegetative propagation—render it less suited to biocontrol by seed-feeding insects than are thistle species bearing perfect flowers and reproducing only by seed. Forsyth and Watson (1985), among others, have emphasized the problem of controlling perennial, asexually propagating weeds and the complexity of evaluating herbivore stress on such species.

Assuming that *L. planus* feeds primarily on ovarioles and other reproductive structures, its impact on Canada thistle may be minimal. That this plant flourishes in areas where the weevil is present suggests that weevil populations exert little herbivore pressure. In recognizing potentially effective agents in the biocontrol of weeds, Goeden (1983) severely downgrades an insect that has been accidentally introduced and established on the target weed, as is the case with *L. planus*. To detect such fortuitous immigrants, he advocates a "pre-introduction faunistic survey" of the weed species requiring control. Rather than dismiss *L. planus* as a possible biocontrol agent of Canada thistle, however, we suggest that its widespread occurrence in the eastern United States allows it to be studied for possible release in other areas of North America where the plant is a pest.







Figs. 2, 3. Dorsal (a) and lateral (b) habitus of adult weevils. 2, *Larinus planus*. 3, *Rhinocyllus conicus*.

Larinus planus and *Rhinocyllus conicus*

In northern Maryland and southern Pennsylvania, *L. planus* and *R. conicus* may be found in mixed stands of Canada, musk, and plumeless thistles. Beyond the range limits here given for *L. planus,* we do not know how extensive the area of sympatry is, or may become. The two weevils are superficially similar in size, form, color, and dorsal vestiture pattern, but they are easily distinguished by rostral form and vestiture (Figs. 2, 3). No other similar weevils are likely to be encountered on thistles in North America, but several other native cleonine weevils (in "*Cleonis*" and *Lixus*) have a similar general habitus. The rostrum in *L. planus* is much more slender (not less than 2.5 times as long as wide) than in any of the *Lixus*-like "*Cleonis.*" *Larinus planus* differs from native *Lixus* spp. by having broadly rounded postocular lobes on the pronotum. Further details are in the following key.

Key to Genera and Immigrant Species of Cleoninae in America North of Mexico

In the following key, we accept as Cleoninae the taxa listed in O'Brien and Wibmer (1982), except that *Lepyrus* has been transferred to Hylobiinae (Morimoto, 1982; O'Brien and Wibmer, 1984). With the arrival of *L. planus* and *R. conicus* in North America, Kissinger's (1964) key to genera is obsolete. Moreover, members of still other palearctic cleonine genera are being considered for importation. According to S. Clement (pers. comm.), one species of *Bangasternus* is in final developmental stages as a biological control agent for yellow starthistle, *Centaurea solstitialis* L.; another *Bangasternus* species is under consideration for control of diffuse knapweed, *Centaurea diffusa* Lam., as is a species of *Eustenopus* for control of yellow starthistle. *Cyphocleonus achates* (Fahraeus) is another potential biocontrol agent for diffuse knapweed (R. S. Anderson, pers. comm.); this species will trace to "*Cleonis*" in the following key.

In addition to these taxa, various other species of *Larinus* are potential biological control agents, but we know of none scheduled for imminent release. Some such species may not key properly; our key is intended to aid only in identification of thistle Cleoninae in North America, not to solve generic problems. The native species keyed below as "*Cleonis*" include numerous taxa of undecided generic affinities, some of them difficult to distinguish from *Lixus*.

1. In dorsal view, rostrum from apex of epistoma to anterior margin of eye about as long as greatest width 2
– In dorsal view, rostrum from apex of epistoma to anterior margin of eye much longer than greatest width 5
2. Elytral intervals each with conspicuous row of erect setae (*Microlarinus*; 2 species, deliberately introduced for control of puncturevine, *Tribulus* spp.) 3
– Elytral intervals without row of erect setae 4
3. Elytral interval 2 widened and elevated at base; body generally more slender, pronotum generally conspicuously narrowed behind middle (reported from AZ, CA, & WA (O'Brien and Wibmer, 1982), seen also from NM, TX, Chihuahua, & St. Kitts (NMNH)) ..... *Microlarinus lypriformis* (Wollaston)
– Elytral interval 2 not widened or elevated at base; body generally less slender (i.e., pronotum tends to be wider than long, elytra tend to be less than twice as long as wide), pronotum generally not conspicuously narrowed behind middle (reported from AZ, CA, NM, TX, & WA (O'Brien and Wibmer, 1982), seen also from KS, OK, Chihuahua, Sonora, & Yucatan (NMNH)) ..... *Microlarinus lareynii* (Jacquelin du Val)
4. Prosternum sharply bicarinate and deeply excavate in front of coxae; not presently in North America, but some palearctic species are potential candidates for importation as biological control agents ..... *Bangasternus*
– Prosternum neither bicarinate nor excavate in front of coxae (deliberately introduced for control of *Carduus* and *Silybum* thistles, now widespread in North America) ..... *Rhinocyllus conicus* (Froelich)
5. Rostrum deeply, longitudinally trisulcate (adventive in North America,

known from MI, NY, ON, PA, & PQ (Batra et al., 1981); develops in roots of Canada thistle and bull thistle, *Cirsium vulgare* (Savi) Ten. (Anderson, 1957)) ..... *Cleonis piger* (Scopoli)

– Rostrum not longitudinally trisulcate (with or without narrow median carina, without median sulcus) 6

6. Rostrum robust, in dorsal view from apex of epistoma to anterior margin of eye less than twice as long as greatest width; or, if rostral length slightly greater (up to 2.2 times as long as wide), then flanks of pronotum with broadly rounded postocular lobes and short vibrissae, or elytra strongly vittate dorsally; with or without prominent antecoxal prosternal tubercles; with or without prominent median rostral carina; with or without distinct adhesive pads on hind tarsus (numerous species of varied form and undecided taxonomic status; under study by R. A. Anderson) ..... "*Cleonis*"

– Rostrum slender, in dorsal view from apex of epistoma to anterior margin of eye at least twice as long as greatest width; if rostral length less than 2.3 times as long as wide, then flanks of pronotum with feebly developed or denticulate postocular lobes and long vibrissae, and elytra not vittate dorsally (may have lateral vittae); without prominent antecoxal prosternal tubercles; without prominent median rostral carina; with distinct adhesive pads on tarsomeres 1–3 of hind tarsus 7

7. Pronotum and elytra with long, erect, hairlike setae (not presently in North America, but some palearctic species are potential candidates for importation as biological control agents) ..... *Eustenopus*

– Pronotum and elytra without long, erect, hairlike setae 8

8. Flanks of pronotum with feebly developed or denticulate postocular lobes and long vibrissae (numerous native species) ..... *Lixus*

– Flanks of pronotum with broadly rounded postocular lobes and fringe of short vibrissae (adventive in North America, known from MD, NY, OH, PA; presumably develops in flower buds and heads of Canada thistle) ..... *Larinus planus* (F.)

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Literature Cited

Allen, A. A. 1975. *Larinus planus* F. (Col., Curculionidae) in West Sussex, etc. Entomol. Mon. Mag. 110: 66.

Anderson, D. M. 1957. Notes on *Cleonus piger* (Scop.) in the United States (Coleoptera, Curculionidae). Coleopt. Bull. 10: 81–85.

Batra, S. W. T. 1980. First establishment of *Rhinocyllus conicus* (Froelich) in Maryland and Pennsylvania for thistle control (Coleoptera: Curculionidae). Proc. Entomol. Soc. Wash. 82: 511.

Batra, S. W. T., J. R. Coulson, P. H. Dunn, and P. E. Boldt. 1981. Insects and fungi associated with *Carduus* thistles (Compositae). U.S. Dep. Agric. Tech. Bull. No. 1616. 100 pp.

Detmers, F. 1927. Canada thistle, *Cirsium arvense* Tourn.; field thistle, creeping thistle. Ohio Agric. Exp. Stn. Bull. 414. 45 pp.

Forsyth, S. F. and A. K. Watson. 1985. Stress inflicted by organisms on Canada thistle. Proc. VI Int. Symp. Biol. Contr. Weeds, Vancouver, 1984 (in press).

Goeden, R. D. 1983. Critique and revision of Harris' scoring system for selection of insect agents in biological control of weeds. Prot. Ecol. 5: 287–301.

Hill, R. J. 1983. Canada thistle, *Cirsium arvense* (L.) Scop. Regul. Hortic. 9(1–2): 27–34.

Hoffmann, A. 1954. Faune de France. 59, Coléoptères Curculionides (Part 2). P. Lechevalier, Paris, pp. 487–1208.

Kissinger, D. G. 1964. Curculionidae of America north of Mexico: a key to the genera. Taxonomic Publications, South Lancaster, Massachusetts. 143 pp.

Maw, M. G. 1976. An annotated list of insects associated with Canada thistle (*Cirsium arvense*) in Canada. Can. Entomol. 108: 235–244.

Moore, R. J. 1975. The biology of Canadian weeds. 13. *Cirsium arvense* (L.) Scop. Can. J. Plant Sci. 55: 1033–1048.

Morimoto, K. 1982. The family Curculionidae of Japan. I. Subfamily Hylobiinae. Esakia (19): 51–121.

Morris, M. G. 1983. Abundance of *Larinus planus* (F.) and *Rhinocyllus conicus* (Frölich) (Col., Curculionidae) in Dorset and adjacent counties. Entomol. Mon. Mag. 119: 42.

O'Brien, C. W. and G. J. Wibmer. 1982. Annotated checklist of the weevils (Curculionidae *sensu lato*) of North America, Central America, and the West Indies (Coleoptera: Curculionoidea). Mem. Am. Entomol. Inst., Ann Arbor, Michigan. No. 34. 382 pp.

———. 1984. Annotated checklist of the weevils (Curculionidae *sensu lato*) of North America, Central America, and the West Indies (Coleoptera: Curculionoidea)—Supplement 1. Southw. Entomol. 9: 286–307.

Peschken, D. P. 1981. *Cirsium arvense* (L.) Scop., Canada thistle (Compositae), pp. 139–146. *In* J. S. Kelleher and M. A. Hulme, eds., Biological Control Programmes Against Insects and Weeds in Canada 1969–1980. Commonwealth Agricultural Bureaux, Slough, England.

Rees, N. E. 1977. Impact of *Rhinocyllus conicus* on thistles in southwestern Montana. Environ. Entomol. 6: 839–842.

Ter-Minasyan, M. E. 1978. Weevils of the subfamily Cleoninae in the fauna of the USSR. Tribe Lixini. (Transl. from Russian.) Amerind Publ. Co., New Delhi. 166 pp.

White, J. C. 1972. A European weevil, *Larinus carlinae* Olivier, collected in Maryland. U.S. Dep. Agric. Coop. Econ. Insect Rep. 22(26): 418.

Zwölfer, H. 1965. Preliminary list of phytophagous insects attacking wild Cynareae (Compositae) species in Europe. Commonw. Inst. Biol. Control Tech. Bull. No. 6, pp. 81–154.

Zwölfer, H., K. E. Frick, and L. A. Andres. 1971. A study of the host plant relationships of European members of the genus *Larinus* (Col.: Curculionidae). Commonw. Inst. Biol. Control Tech. Bull. No. 14, pp. 97–143.

Zwölfer, H. and P. Harris. 1984. Biology and host specificity of *Rhinocyllus conicus* (Froel.) (Col., Curculionidae), a successful agent for biocontrol of the thistle, *Carduus nutans* L. Z. Angew. Entomol. 97: 36–62.