COLONIZATION OF THE NORTHEASTERN UNITED STATES BY TWO PALEARCTIC MOTHS (LEPIDOPTERA: TORTRICIDAE)

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Thirty years ago, two Palearctic tortricids, *Croesia forskaleana* (Linnaeus) and *Clepsis unifasciana* (Duponchel), were recorded in the Nearctic from Long Island, New York (Klots 1941). Almost no information on their progress has been published, but specimens subsequently collected on another island and at several points on the mainland indicate that these immigrants are spreading. Because rapid range changes are potentially useful in analyzing microevolution (see, e.g., Baker and Stebbins 1965; Burns 1966) — the more so as they are accurately documented — we attempt here to put the scene together, to interest other workers in future developments, and to encourage accelerated deposition of specimens in institutional collections.

Although numerous lepidopteran and other insect species have reached the United States from the Old World and become established (e.g., Popham and Hall 1958), many came so early, or were so unspectacular after arriving, that their American history is obscure. The rare detailed accounts of spread deal with species such as the gypsy moth, *Porthetria dispar* (Linnaeus) (Corliss 1952), and the spotted alfalfa aphid, *Therioaphis maculata* (Buckton) (Smith 1959), which are conspicuous or economically important (or both).

A few introductions of Microlepidoptera have been fairly well chronicled, such as that of the tortricid *Cnephasia longana* (Haworth) on the Pacific Coast (Powell 1964*a*); but most have not. At worst, as in California populations of the fungus-eating *Oinophila v-flava* (Haworth), a long gap in the temporal record, together with complex ecological and distributional data from the present, make an unequivocal choice between native and alien status impossible (Powell 1964*b*; Lawrence and Powell 1969). The crucifer-eating diamondback moth, *Plutella maculipennis* (Curtis), and various cosmopolitan household pests like the Indian meal moth, *Plodia interpunctella* (Hübner), and the clothes moth, *Tineola biselliella* (Hummel), have been in North America so long that neither their beachheads nor their invasion patterns are known. Even

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Manuscript received by the editor April 29, 1971.

Fig. 1. *Croesia forskaleana,* male, dorsal view. New Market, Middlesex County, New Jersey, VI-17-1968.

Fig. 2. *Croesia forskaleana,* female, dorsal view. Palearctic.

Fig. 3. *Clepsis unifasciana,* male, dorsal view. Palearctic.

Fig. 4. *Clepsis unifasciana,* female, dorsal view. Palearctic.

some rather recently introduced species have been so overlooked or ignored that only a vague rendering of their Nearctic history is possible. Three parallel cases involve Palearctic moths, the tortricids *Acleris variegana* (Schiffermüller) and *Batodes angustiorana* (Haworth) (Powell 1964*a*) and the oecophorid *Borkhausenia* (*Batia*) *lunaris* (Haworth) (Powell 1964*c*): each inhabits parts of the Pacific Northwest and central coastal California without revealing whether it entered North America once and in the north, or once but to the south, or twice.

Often there are several records of an alien species from about the time it was first noticed and a relative or absolute dearth of them for a long period thereafter. Even in so well sampled a group as butterflies, the Palearctic hesperiid *Thymelicus lineola* (Ochsenheimer) — which can quickly attain enormous population densities in newly colonized areas — was discovered at one locality in North America in 1910 and observed there for five years but was rarely recorded from anywhere for the next thirty years or more, in which it must have spread far in all directions from its origin (Burns 1966).

For the two tortricids treated here, records are also intermittent in time and space. But the gaps are comparatively short and may not seriously hinder efforts at reconstructing New World movements of these moths.

Croesia forskaleana (Linnaeus)

Phalaena Tortrix forskaleana Linné, 1758, Syst. Natur., ed. 10, p. 531.
Argyrotoxa forskaleana: Klots, 1941, Bull. Brooklyn Entomol. Soc., **36**: 126; Beckwith, 1962, Sci. Tree Topics, 2(9): 15.
Croesia forskaleana: Obraztsov, 1956, Tijdschr. v. Entomol., **99**: 127 (synonymy); MacKay, 1962, Canadian Entomol., Suppl. **28**: 10 (larva).

Diagnosis. — The ochreous yellow forewings of this species differ from the lemon yellow ones of native Nearctic species of *Croesia.* The delicate, reddish reticulation and the transverse blackish mark — which varies from a thin, median line, outwardly angulate in the cell, to a broad blotch on the mid dorsum — also distinguish *C. forskaleana* (figs. 1 and 2). *Croesia semipurpurana* (Kearfott) and *C. curvalana* (Kearfott) are native species that sometimes show blackish dorsal marking, but in them it is expressed as a broad blotch in the tornal region. All native species of *Croesia* have curving bands of shining rosaceous or lavender across the forewing, while *C. forskaleana* does not.

Male and female genitalia of *C. forskaleana* are figured by Pierce and Metcalfe (1922).

Geographic distribution. — *Croesia forskaleana* ranges widely in the Old World, from Great Britain and central and southern continental Europe to the Caucasus (Meyrick 1895; Obraztsov 1956).

For the United States, Klots (1941) gave a 1939 record from western Long Island, New York, and cited W. T. M. Forbes as authority for specimens dating back to 1934 from the northeastern tip of that island. Our data, which include an earlier record (1932) for the latter area, suggest a sequence of more or less steady spread. *Croesia forskaleana* was established in eastern Long Island by the early 1930's and at the western end of the island and adjacent mainland New York (Westchester County) by the late 1930's. After two more decades — in which there were no mainland records beyond the New York City area — it was collected in westcentral Connecticut (1959), central Connecticut (1962), and east coastal and central New Jersey (1962) (fig. 5). Together, these records point to a multidirectional expansion of the moth on the mainland.

Croesia forskaleana was found on a second island, Martha's Vineyard, Massachusetts, in 1944. It probably got there at about that time because it did not turn up in the course of a long survey of the Lepidoptera of Nantucket and Martha's Vineyard islands (Jones and Kimball 1943), which was "completed" in 1942. Several points attest to the exhaustiveness of that survey: ". . . the Marthas Vineyard records are based [principally] upon the observations and

Fig. 5. Spatial distribution of *Croesia forskaleana* in North America. Earliest known year of occurrence at each locality is given. (The map shows the northeastern United States from Massachusetts to New Jersey.)

collections of the author [F. M. Jones], beginning in 1913, continued in 1917, 1921, 1925, and thereafter each year from 1927 to 1942. For twelve consecutive years a light-trap was operated all night, on all nights not too stormy, and usually from late June to early or mid-September" (Jones and Kimball 1943: 25). It was F. M. Jones himself who collected this species on Martha's Vineyard, not only in 1944 but also in 1949. Negative evidence that we have accumulated from adjacent parts of the mainland suggests that Martha's Vineyard was colonized via air movement directly from Long Island — an overwater distance of as little as 60 miles.

Biology. — Various European workers have stated that larvae of *C. forskaleana* feed on maple (*Acer*). Ford (1949: 56, 214, 218) specifically gave *A. campestre* and *A. pseudoplatanus* as foodplants

in England. Beckwith (1962) recorded a native American maple, *A. saccharum,* as a host in southwestern Connecticut; and MacKay (1962) examined larvae collected from maple on Long Island, New York. The larvae are generally described as leaf rollers.

Besides *Acer,* Kennel (1910: 170) mentioned *Rosa centifolia* as a foodplant of *C. forskaleana;* but, because a related moth of similar appearance — *C. bergmanniana* (Linnaeus) — is known to be a *Rosa* feeder, this record may stem from a misidentification. Taking Kennel almost verbatim (but without citing him at that point), Swatschek (1958: 72) uncritically repeated Kennel's *Rosa centifolia* record. MacKay (1962: 10), citing Swatschek (1958), then simply included *"Rosa"* in a list of three *C. forskaleana* foodplants. To *Rosa* and maple, MacKay — citing Ford (1949) — added "sycamore," which in North America is usually taken to mean *Platanus,* but which Ford and other Englishmen habitually apply to *Acer pseudoplatanus!* The literature would appear to be evolving in the direction of indiscriminate polyphagy.

In Europe larvae are said to occur in May and June, pupae in June and July, and adults from the end of June to mid August (Meyrick 1895; Kennel 1910; Ford 1949). Our early and late records for colonizing adults are June 1 and August 1, with most records falling between June 19 and July 17.

Apparently no detailed studies have been made, but it is likely that winter is passed by eggs in diapause, as is true of *Croesia albicomana* (Clemens) (Powell 1964*a*). This supposition is supported by the fact that females taken in Connecticut and New York have dirt particles in the ovipositor setae. Presumably these particles are spread onto the eggs at oviposition. This behavior, which is accompanied by well developed structural modification in certain cnephasiine Tortricinae, is also thought to occur in a few other Tortricini — such as *Acleris foliana* (Walsingham) — all of which hibernate in the egg stage (Powell 1964*a*). Debris transfer during oviposition has not been recorded for *Croesia.*

Material examined. — CONNECTICUT: *Middlesex Co.,* Middletown, 2♀ VII-7 and 8-62, 1♀ VIII-1-62, 4♂, 2♀ VII-15 to 19-63 (J. M. Burns). *New Haven Co.,* Waterbury, 1♂ VI-15-59 (C. W. O'Brien). MASSACHUSETTS: *Dukes Co.,* Martha's Vineyard, 1♂ VII-23-44, 2♂ VI-29 and 30-49 (F. M. Jones). NEW JERSEY: *Burlington Co.,* Ft. Dix, near Wrightstown, 1♂ VI-24 to VII-1-62 (light trap). *Middlesex Co.,* New Market, 1♂ VI-17-68 (black-light trap). *Monmouth Co.,* Ft. Monmouth, near Eatontown, 1♂ VII-9 to 15-62 (light trap). NEW YORK: *Nassau Co.,* Sea

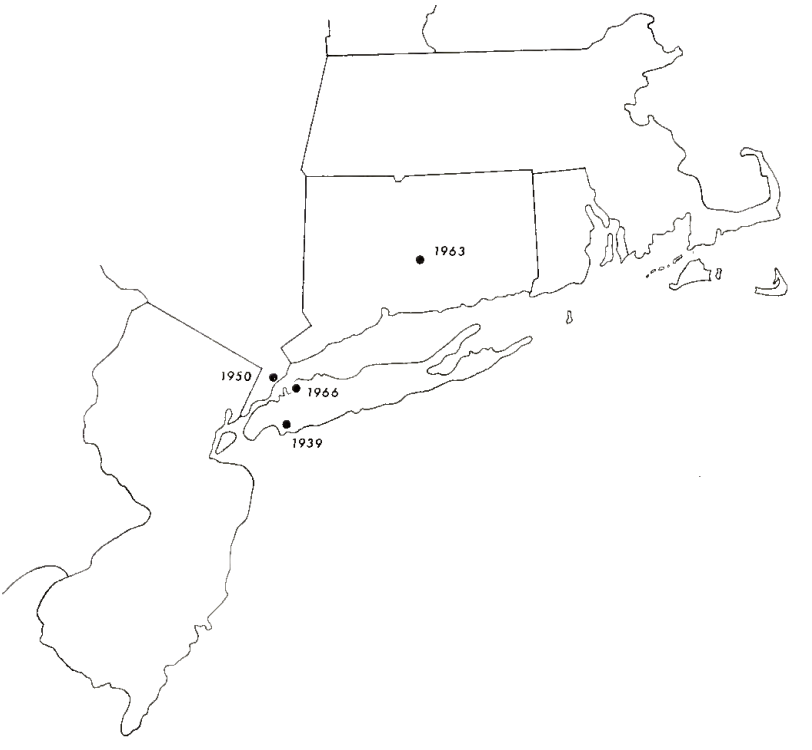

Fig. 6. Spatial distribution of *Clepsis unifasciana* in North America. Earliest known year of occurrence at each locality is given. (The map shows the northeastern United States from Massachusetts to New Jersey.)

Cliff, 2♀ VII-5-66 (A. Diakonoff and J. Powell); Valley Stream, 2♂ VII-1-39 (A. G. Richards, Jr.). *Orange Co.,* West Point, 1♂ VI-16-64 (B. Mather). *Suffolk Co.,* Eastport, 1♂ VI-1-41 (D. Raynor); Mattituck, 1♂ VI-16-32, 1♀ VI-30-37, 1♂ VII-8-46 (R. Latham); Orient, 1♂ VI-15-34, 1♀ VII-2-35, 1♂ VI-18-36, 1♂ VII-30-36, 1♀ VII-6-47 (R. Latham); Tuckahoe, 1♂ VII-11-39 (collector unknown). *Westchester Co.,* Mt. Vernon, 1♂ VII-20-38 (collector unknown); Ft. Slocum, New Rochelle, 20♂, 1♀ VI-25 to VII-2-62 (light trap); Pelham, 3♂, 4♀ VII-17-50, 28♂, 25♀ VI-19 to VII-22-54, 1♂ VII-?-59 (A. B. Klots). *County undetermined,* Little Neck, 1♀ VI-23-57, 1♂ VI-28-58 (J. K. Terres); Long Island, 1♂ VI-10-59 (F. J. Davis); New York City, 1♂ VII-3-59 (T. Glidaspow).

Clepsis unifasciana (Duponchel)[3]

Tortrix unifasciana Duponchel, 1843, Hist. Natur. Lépid. France, Suppl. 4: 135; Klots, 1941, Bull. Brooklyn Entomol. Soc., 36: 126.

Clepsis unifasciana: Obraztsov, 1955, Tijdschr. v. Entomol., 98: 215 (synonymy).

Diagnosis. — *Clepsis unifasciana* most closely resembles *C. peritana* (Clemens) and *C. virescana* (Clemens) among Nearctic species but has a rusty or reddish brown tint. From *C. peritana* it differs also in having a well developed costal fold in the male and a less distinctly marked forewing; from *C. virescana,* in having a longer costal fold, no strongly contrasting outer costal spot, and a dark gray (rather than pale) hindwing (figs. 3 and 4). With their forewing patterns usually obscure, females of all three species look more similar than the males; but the lack of any differentiation of the outer costal spot and the rust-orange coloration of the forewing distinguish *C. unifasciana* females.

The male genitalia of *C. unifasciana* are at once set apart by the elongate, curving, flattened setae of the medial face of the valva (see Obraztsov 1954; Pierce and Metcalfe 1922). The female genitalia have an elongate sclerotized band in the ductus bursae, somewhat as in *Archips argyrospilus* (Walker), and are unlike *C. peritana* and *C. virescana.*

Geographic distribution. — *Clepsis unifasciana* is widespread in the Palearctic, having been recorded from the British Isles, mainland Europe, northwest Africa, Turkey, Syria, and the Amur and southern Ussuri region of the eastern Soviet Union (Meyrick 1895; Kennel 1910; Obraztsov 1955).

In the Nearctic we know of only four localities. Klots' (1941) record was based on specimens taken at Valley Stream, New York, in western Long Island in 1939. Our latest record comes from this same general area. Klots was next to collect the species, 11 years later, immediately north of New York City on the mainland. After another 13 years, *C. unifasciana* was found in central Connecticut (fig. 6).

Biology. — In Europe this species feeds on privet, *Ligustrum vulgare* (Meyrick 1895; Kennel 1910); and at Valley Stream, New York, A. G. Richards, Jr., found adults of *C. unifasciana* excessively

[3]Bradley and Martin (1956) exhumed the name *consimilana* Hübner, 1822, for this species and relegated *unifasciana* to synonymy. The Hübner name had been treated as of doubtful status by Obraztsov (1955) and others, presumably because there is no type; Bradley and Martin gave no explanation for their reversal.

common on a privet hedge (Klots 1941). Ford (1949), citing Wakely, also listed ivy (*Hedera helix*) and apple (*Pyrus malus*) as foodplants in England. According to Kennel (after Disqué) and Ford, larvae begin eating in summer, overwinter, and then complete their growth in spring, pupating in June; and adults fly in June and July. American records of adults range from May 30 to July 22, with most occurring between June 19 and July 5.

Material examined. — CONNECTICUT: *Middlesex Co.*, Middletown, 1♂ VII-18-63 (J. M. Burns). NEW YORK: *Nassau Co.*, Sea Cliff, 11♂, 7♀ VII-5-66 (A. Diakonoff and J. Powell); Valley Stream, 5♂ VII-1-39 (A. G. Richards, Jr.). *Westchester Co.*, Pelham, 1♂ VII-17-50, 1♀ VII-2-53, 36♂, 18♀ V-30 to VII-22-54, 1♂ VI-23-56, 1♂ VI-?-59 (A. B. Klots).

Discussion

Sporadic data indicate that, subsequent to their initial discovery on Long Island, New York, in the 1930's, *Croesia forskaleana* and *Clepsis unifasciana* reached the adjacent mainland and spread considerably. Indeed, *Croesia forskaleana* not only fanned out in all possible directions on the mainland but also apparently jumped from Long Island to Martha's Vineyard, an island in Massachusetts about 60 miles eastnortheast of Long Island. This jump is not surprising because it is known that major air masses often move up the Atlantic Coast; that various southern species of Lepidoptera have, at one time and another, briefly attained Martha's Vineyard and Nantucket; and that many moths have permanently settled these islands without human assistance (Jones and Kimball 1943).

Although both immigrant tortricids are thriving in some places, *Croesia forskaleana* seems to be the better colonizer (cf. figs. 5 and 6). It may have had a head start: our earliest record of it (1932) precedes the earliest record of *Clepsis unifasciana* (1939) by seven years. On the mainland, *Croesia forskaleana* was collected first just north of New York City in 1938. In 1950 both species were taken in that area at Pelham — the only mainland locality being sampled even intermittently at that time — and in 1954 both were extremely common there. Both moths are univoltine; and, to judge from their broad Palearctic ranges, both (especially *Clepsis unifasciana*) must be ecologically tolerant at temperate latitudes. *Croesia forskaleana* is a maple (*Acer*) eater and *Clepsis unifasciana* is (at least primarily) a privet (*Ligustrum*) eater. Foodplant availability, then, should not notably delay the northeastern invasion of either species. Yet, on an average, the maple-eating *Croesia*

forskaleana may be able to cross interurban zones a little more easily than *Clepsis unifasciana* because several maples are important in the native flora and abundant in rural situations (as well as in cities), whereas all privet is introduced and the majority is planted in yards and kept grounds (albeit a substantial amount has escaped and become established in open woods, in thickets, and along roadsides).

The picture of colonization is sketchy, owing in large measure to a paucity of collectors in the Northeast who are interested in local Microlepidoptera. Ironically, however, Powell's Law — which states that "no systematic entomologist voluntarily works on insects that occur within 1,000 miles of his home laboratory" (Munroe 1969) — has helped as well as hurt: mainland spread has been documented chiefly by workers who left California and sampled northeastern tortricids in our behalf. Since this activity began only in the late 1950's and was casual, the long lag in appearance of peripheral records beyond the immediate vicinity of New York City, and even the apparent distributional limits themselves, may be artifacts. One or both species may have expanded in New England and states to the south earlier or farther than our records show. Both moths are attracted to lights, sometimes in large numbers, and both are adapted to urban situations. Therefore it would not seem too idealistic to hope that collectors residing in the megalopolis — particularly at its northern and southern ends in the areas of Boston and Washington — might watch for these tortricids and sharpen our view of their expanding perimeters.

ACKNOWLEDGEMENTS

We owe much of our information to two individuals who deliberately gathered northeastern Microlepidoptera for us. C. W. O'Brien (Texas Tech University, Lubbock), while a student at the University of California, Berkeley, made a collection in Connecticut. P. A. Opler (Organization for Tropical Studies, San José, Costa Rica) accumulated a large number of light-trap samples from Massachusetts, Rhode Island, New York, and New Jersey as a by-product of work with the U. S. Army in 1962. These collections, together with those we made, are deposited in the California Insect Survey, University of California, Berkeley, and in the Museum of Comparative Zoology, Harvard University, Cambridge.

C. P. Kimball (Barnstable, Massachusetts) responded to queries on the occurrence of the two species in the area of Cape Cod and adjacent islands. The following persons permitted use of material

in institutional and private collections in their care: A. B. Klots and F. H. Rindge (American Museum of Natural History, New York); Bryant Mather (Clinton, Mississippi); and R. W. Hodges (U. S. National Museum, Washington).

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