SELECTED FRESHWATER

INVERTEBRATES PROPOSED FOR SPECIAL CONCERN

STATUS IN MASSACHUSETTS

(MOLLUSCA, ARTHROPODA)

(PART II)

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Cover

The snail Valvata sincera
and the crayfish Cambarus bartonii

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INTRODUCTION

About two years have passed since Part One appeared that listed five freshwater invertebrate species proposed for special concern status in Massachusetts (Smith, 1981). In that time other species have been evaluated as candidates for special concern status and, no doubt, as work continues, still others will be eventually listed under a special concern category. During the same time span no new progress has been made to protect animal and plant species occurring in Massachusetts that are in some way threatened or endangered. However, legislation has been recently enacted initiating a Non-game Wildlife Tax Check-Off Program in Massachusetts. Additionally the Massachusetts Division of Fisheries and Wildlife, under the Natural Heritage Program, has made contributions by exploring methods by which private land owners and state agencies can cooperate to draw attention to areas containing rare species.

The five species proposed for special concern status herein are those either recently discovered in Massachusetts with restricted distributions or species long known in the Commonwealth and either declining or in danger of decline. Several other invertebrate species are known in Massachusetts from only a few localities but because of their reputation for sporadic (or cyclic) occurrences and passive (phoretic) dispersal capabilities during the egg stage (which allows them to be carried about by other animals) they are not formally included at this time. However, their biology alone may not be the exclusive reason for rareness. The more notable of these species are listed briefly below and may be considered of "undetermined status."

Craspedacusta sowerbyi Lankester Freshwater jellyfish

Urnatella gracilis Leidy Branched moss animal

Cristatella mucedo Cuvier Creeping moss animal

Hyalinella punctata (Hancock) Hyaline moss animal

Eubranchipus intricatus Hartland-Rowe Intricate fairy shrimp

Species Proposed for Special Concern Status

The five species introduced in this report as new candidates for special concern status are listed below. Extensive collecting over the last three years plus examination of museum records from the New England region have provided substantial information enabling a presentation of the status of these species. As more information develops other species undoubtedly will be nominated for special concern status in Massachusetts, such as those species listed above.

MOLLUSCA

Pelecypoda

Lampsilis cariosa (Say, 1817)

Gastropoda

Valvata sincera Say, 1824

ARTHROPODA

Amphipoda

Stygobromus tenuis tenuis (Smith, 1874)

Gammarus pseudolimnaeus Bousfield, 1958

Decapoda

Cambarus bartonii (Fabricius, 1798)

SPECIES ACCOUNTS

Mollusca

Pelecypoda

Lampsilis cariosa Yellow river-mucket (Figure 1)

The yellow river-mucket is a large distinctive species of mussel that is distinguished from other mussel species inhabiting Massachusetts by its broad ovoid shape and the bright yellow color of the outer part (periostracum) of the shell. The valves of the shell possess fully developed, articulating hinge teeth. The only species which can be confused with *L. cariosa* is *Leptodea ochracea*, a species previously proposed for special concern status (Smith, 1981). In Massachusetts, *L. cariosa* is found only in large rivers whereas *L. ochracea* is confined to coastal freshwater ponds. Both species exhibit exceptional differences in anatomy and *L. cariosa* is larger, ranging up to 120 mm in length. Other subtle, but distinct differences in shell characters exist between these two species and readers are referred to Johnson (1947, 1970) for a discussion of these characters.

Lampsilis cariosa has been reported from most major rivers along the Atlantic coast from Georgia to Nova Scotia (Johnson, 1947, 1970; Clarke and Rick, 1963). In Massachusetts the species was historically known from the Merrimack River near Haverhill (MCZ[1], ANSP[2]) and throughout the Connecticut River (Map 1). Many of the early records are given by Johnson (1947).

In recent years, shells of recently deceased animals have been located in the Connecticut River in Sunderland (Franklin County). The only living specimens observed and collected in the Connecticut River since 1976 (UMA[3] AR.1007) have been from the Holyoke Power Company canals, which are connected with the Connecticut River, in Holyoke (Hampden County). The rarity of shells and living specimens leads to the conclusion that the species is rare and declining in the Connecticut River. The species has possibly been extirpated from the Merrimack River in Massachusetts as no living specimens nor shells have been collected there since the mid-Nineteenth century (MCZ and ANSP collections).

As with all other North American species of freshwater mussels, *L. cariosa* produces a larva (glochidia) which is an obligate fish parasite during early development. Eggs are deposited into the marsupial gills of the female parent mussel in mid-summer and are brooded until the following spring when the larvae (glochidia) are released to seek out suitable fish hosts to complete development. The host fish species for *L. cariosa* is (are) unknown.

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[1] Museum of Comparative Zoology, Harvard University, Cambridge

[2] Academy of Natural Sciences, Philadelphia

[3] Museum of Zoology, University of Massachusetts, Amherst

The principal reason for the decline of L. cariosa in Massachusetts is thought to be organic and/or toxic pollution. The two larger rivers which have supported this species have been subjected to various levels of inorganic and organic pollution for many years. Because the species is rheophilic (river inhabiting) damming and interupting the flow of rivers also has had some affect over a period of time. Presently, the practice of frequently altering the flow and water level of the Connecticut River by electric utility companies seems a likely threat because shoal areas potentially containing the species (and other mussel species as well) are exposed or nearly exposed during periods of extreme low flow. The Merrimack River still receives some pollution from bordering communities although the overall quality of the river has improved considerably in recent years (Anon., 1982).

Although the species is not listed as either threatened or endangered under federal legislation (Endangered Species Act, 1982), certain states have classified this species under various categories of special concern. Fuller (1976) has listed L. cariosa under special concern status in South Carolina because of its restricted distribution, and Dennis (in Linzey, 1979) considered the species as endangered in Virginia due to its "peripheral occurrence."

Gastropoda

Valvata sincera Boreal turret snail (Figure 2)

This small snail species is distinguishable from other freshwater gastropods in Massachusetts by the concentric structure of the operculum, or "door," by which the animal is sealed in the shell, and the smooth, circular, and rapidly expanding whorls of the shell. The only other member of the gastropod family Valvatidae in Massachusetts is V. tricarinata, a common and widespread species distinguished from V. sincera by the raised ridges or keels found on the shell surface.

The taxonomy of V. sincera, its various subspecies, and a closely allied form, V. lewisi, is not clearly defined. Although specific status of each taxon has been maintained in several papers spanning a lengthy period (e.g., Walker, 1906; Burch, 1982), a recent critical study on these snails (Clarke, 1973) concluded that the two "species" are one. The present report follows Clarke (1973).

Valvata sincera was first documented from Massachusetts (as V. lewisi) by Ludlam et al. (1973) who reported it from Stockbridge Bowl (Lake Mahkeenak), in Stockbridge, Massachusetts (Berkshire County) (Map 2). A few additional specimens have been collected in nearby Lily Pond, a small 14 acre pond draining to Stockbridge Bowl. Both bodies of water are in the Housatonic River drainage. Jokinen (1983) lists a record from Lake Cochituate in Natick (Middlesex County). Lake Cochituate is in the Merrimack River watershed. No other Massachusetts records exist.

Valvata sincera is a species of large lakes and ponds and is rarely found outside of these habitats in the southern part of its range. The species normally occurs in fairly deep water (> 2 meters) and is often associated with rooted aquatic vegetation (Clarke, 1973).

Harman and Berg (1971) provide information on certain chemical characteristics of water in which V. sincera (and V. lewisi) occurs in New York. They indicated that the species prefers moderately hard (calcium-rich) water with pH values ranging from 7.6 to 8.3. Jokinen (1983) reports a slightly higher pH (8.9) for a single Connecticut locality. Ludlam et al's (1973) data for Stockbridge Bowl is similar to that of Harman and Berg (1971) and Jokinen (1983). Stockbridge Bowl is a hard water lake (CaCo3 alkalinity 104 to 142 mg/l) with a pH varying around 8.0 (range 7.0 to 9.0). The species was reported in water from less than 2 meters to 4 meters in depth.

Information concerning the life history of V. sincera is fragmentary. Heard (1963) showed that this species, and others in the genus, lays eggs which are encapsulated and attached primarily to vegetation, although other types of surfaces are utilized. Valvata sincera lays two to four eggs per capsule (Heard, 1963). Lang and Dronen (1970) reported that adults (of V. lewisi) are present only in summer months and that from two to six eggs are produced per capsule. On the average, two capsules are produced per snail. Lang and Dronen (1970) demonstrated that V. lewisi has a high affinity for plant species in the genus Myriophyllum (water milfoil) as hosts for capsule attachment. Egg laying apparently occurs throughout the summer.

Although V. sincera has a wide range throughout northern North America (Heard, in Burch, 1982), this species, and V. lewisi, are found predominantly in boreal and subarctic regions (Clarke, 1973). Previously, V. sincera (and V. lewisi) were known in New England only from a few lakes in northern Vermont, New Hampshire, and Maine (Johnson, 1915; Nylander, 1930; Clench and Russell, 1939). In southern New England the species is limited to Stockbridge Bowl, Lily Pond, and Lake Cochituate in Massachusetts and a single locality in Connecticut (Jokinen, 1983). These southern populations are probably relicts of a northern dispersal of the species following glacial retreat.

The species is very rare in Stockbridge Bowl. Ludlam et al. (1973) reported it as representing only 1% of 68 benthic samples containing gastropod species at 0 to 2 meters and 11% of 9 gastropod collections at 4 meters. Subsequent spot sampling in 2.5 meters of water during September, 1982, by S. Ludlam (University of Massachusetts) produced just a few individual shells of dead animals. No information is currently available on the status of V. sincera in Lake Cochituate except that it is very rare (E. Jokinen, Pers. Comm.).

The continued existence of V. sincera in the Commonwealth will depend on the maintenance of good water quality in the lakes and ponds containing this species. Ludlam et al. (1973) indicated that Stockbridge Bowl has undergone drastic changes since about 1950. Nutrient levels have increased as the shoreline has been developed. Water clarity has diminished resulting in the decrease of deepwater rooted macrophytes which may be essential for the species' survival. The lake has also been subjected to herbicide treatment (Ludlam et al., 1973). Lily pond is highly eutrophic and has in the past received pollution form the town of Lenox (McCann and Daly, 1972). Chemical and organic pollution of Lake Cochituate is reported to be "heavy" (McCann et al., 1972). Beskenis, et al. (1982) have discussed the nature of pollution of Lake Cochituate and suggested methods of abating further contamination. Valvata sincera is not protected anywhere within its range although Jokinen and Pondick (1981) have listed it as rare and endangered in Connecticut.

Arthropoda

Amphipoda

Stygobromus tenuis tenuis Piedmont ground-water amphipod (Figure 3)

Stygobromus t. tenuis belongs to an extremely diverse assemblage of species, all presently arranged under one genus (Holsinger, 1978). The species are characterized by lacking eyes or pigment and are adapted to living in subterranean environments. Needless to say, the species are difficult to separate without adequate samples or knowledge of amphipod systematics. The most useful guides for the identification of species of Stygobromus are by Holsinger (1967, 1978). Since species of Stygobromus are so rarely encountered in New England, the mere recognition of the genus by use of such guides as Edmondson (1959) and Pennak (1978) can save considerable time in determining the species at hand.

This amphipod species has a discontinuous range along the northeastern Atlantic Coastal Plain. Historically, the subspecies S. t. tenuis was known only from ground-water habitats in eastern Maryland, extreme southeastern New York, and south-central Connecticut. Until recently, the species had not been seen in southern New England since the Nineteenth century (Holsinger, 1967). Two populations of Stygobromus t. tenuis are now known to occur in subterranean waters in the extreme southern Taconic mountains in the town of New Marlborough (Berkshire County) in southwestern Massachusetts (Smith, In press) (Map 3). The habitat of these two populations is completely unlike that described for S. t. tenuis elsewhere (Holsinger, 1967, 1978) in being situated in upland karst areas well removed from the coastal plain. Both localities in southwestern Massachusetts are springs that are presently "capped" by spring houses (structures constructed to hold spring water). Kunkel's (1918) unsubstantiated report of this species from "Canaan," Connecticut, suggests that populations occur over a wider area of the southern Taconic mountains. Readers are referred to Smith (In press) for specific details and a discussion of this species' occurrence in Massachusetts.

The life history of S. t. tenuis, as with most other species of the genus, is practically unknown. Holsinger (1967) provided notes on breeding females collected in Maryland and mentioned the occurrence of a female with developed brood plates in an early Connecticut collection made in December. Since so little is known of the life history of this species, particularly in New England, a full account is presented below of Massachusetts' specimens. Table 1 lists particulars of breeding females for all collections.

As can be determined from Table 1, females of S. t. tenuis produce very few but relatively large, ovoid shaped eggs. Breeding females are somewhat smaller than those reported from Maryland (Holsinger, 1967, 1978). Specimens of the subspecies potomacus are larger still. Among the collections of S. t. tenuis made from one locality in Massachusetts (Benton Hill, UMA AR. 1297), ovigerous females and females with formed brood pouches made up the following percentages of the female sample: 12 May, 1982, 33%; 10 June, 1982, 33%; 30 June, 1983, 66%; 21 Sept., 1982, 80%. The other locality (Brush Hill, UMA AR. 1298) produced the following: 10 June, 1982, 0%; 30 June, 1982, 8%. Females were predominant in the latter locality and it may be that a lack of males caused the extreme low representation of breeding females. As with breeding females, males from Massachusetts' populations are small in overall

Specimen	Collection date	Breeding condition	Length (in mm)	Egg number	Egg size (mm) (average per female)
1	12 May 1982	formed brood plates	5.5	--	--
2	12 May 1982	brooding eggs	6.0	6	0.50 X 0.43
3	10 June 1982	brooding eggs	6.0	5	0.50 X 0.40
4	30 June 1982	brooding eggs	6.5	6	0.67 X 0.53
5	30 June 1983	brooding eggs	5.0	5	0.70 X 0.53
6*	30 June 1983	formed brood plates	7.0	--	--
7	21 Sept. 1982	brooding eggs	6.5	4	0.57 X 0.37
8	21 Sept. 1982	brooding eggs	5.5	6	0.50 X 0.37
9	21 Sept. 1982	formed brood plates	5.5	--	--
10	21 Sept. 1982	formed brood plates	6.0	--	--
$\bar{X}$ (± SD)	--	--	5.95 (±0.60)	5.33 (±0.82)	0.57 (±0.09) X 0.44 (±0.07)

*From Brush Hill, New Marlborough, MA, largest female in all samples.

Table 1. Data from breeding females of Stygobromus t. tenuis collected from the Benton Hill locality (unless otherwise indicated), New Marlborough, Massachusetts.

size relative to specimens from Maryland and Connecticut. The largest male collected from Massachusetts measures 9.5 mm. Overall, male specimens rarely exceed 8 mm.

The high degree of endemism shown by species of Stygobromus, and the usefulness of these animals in showing ground-water drainage patterns and history, has recently generated activity among amphipod biologists to protect subterranean habitats containing these animals. In a recent account on endangered and threatened species in Virginia (Holsinger, in Linzey, 1979) some 25 species of Stygobromus are listed. Included among these species is S. t. potomacus the other subspecies of the S. tenuis group. Presently, S. t. tenuis is not protected anywhere throughout its range. Stygobromus t. tenuis is in need of conservation in Massachusetts because of its unique biological nature (one of very few troglobitic creatures in New England), restricted distribution, and because its presence in specific subterranean environments can provide information on the commonality of ground-water systems and the extent to which ground-water aquifers exist.

Gammarus pseudolimnaeus Northern spring amphipod (Figure 4)

The northern spring amphipod belongs to the amphipod family Gammaridae, a large group of mostly marine species. Of the freshwater species known from North America, only two have been found in Massachusetts; G. fasciatus, a common species of coastal freshwater, and the species discussed herein, G. pseudolimnaeus. Gammarus pseudolimnaeus is not easily distinguished from G. fasciatus or other species of the genus which inhabit freshwaters. Investigators must refer to technical publications (e.g., Bousfield, 1958; Holsinger, 1972) or consult with biologists knowledgeable of the group. Regional publications (e.g., Bell, 1971) and general works (e.g., Pennak, 1978) are helpful as well.

Gammarus pseudolimnaeus is a widespread species occurring throughout the Great Lakes region, upper St. Lawrence River system, and the central and upper Mississippi River system (Bousfield, 1958; Holsinger, 1972; Ciniglio and Payne, 1977). The species was recently reported by Smith (1982) from an isolated locality within the Housatonic River basin in southwestern Massachusetts and the central Hudson River system. Subsequently, the species has been collected in three other localities in southwestern Massachusetts in the town of Sheffield (Berkshire County) and collectively these four proximal records in Massachusetts (Map 4) represent the presently known southeastern range limit of the species along the Atlantic seaboard.

Throughout the greater part of its range, G. pseudolimnaeus inhabits a variety of aquatic environments but seems to have an affinity for springs and spring-streams, particularly during the reproductive season (Bousfield, 1958). In spring-stream areas the species shows a tendency to aggregate in large numbers among beds of vegetation (Clampitt, 1965). In Massachusetts G. pseudolimnaeus is found only in vegetated, calcium-rich springs and spring-fed streams that drain through swampy lowlands to the Housatonic River.

Outside of New England the life history of G. pseudolimnaeus has been extensively studied. Various investigators (Hynes and Harper, 1972; Waters and Hokenstrom, 1980; Miller, 1982) reported that individuals of this species have about a one year life span and reproduction commences as soon as animals reach maturity, either during their first summer or during the following

winter or spring. Females reach maturity at about 6 (Miller, 1982) or 7 (Waters and Hokenstrom, 1980) millimeters in length. Ovigerous females are found from January through November while peak reproduction occurs during the months of April, May, and June. Egg production increases as female size increases and the largest females (up to 15 mm in length) produce as many as 91 eggs (Hynes and Harper, 1972). An average sized female (ca. 11 mm) lays 39 (Miller, 1982) to about 45 (Hynes and Harper, 1972) eggs. It has been suggested that females born in April can mature and produce two broods during the remaining season (Waters and Hokenstrom, 1980).

Data gathered (D. Smith, Pers. observ., 1981-1983) on life history characteristics of Massachusetts' populations show no great differences from results of the studies discussed above. Females were found with eggs on 25 March, 1981; 16 April, 1982; 6 June, 1983; and 1 July, 1979. Egg counts revealed the following estimates: 9 to 10 mm females produce about 15 to 20 eggs, 11 mm females produce about 40 eggs, and 12 mm females produce about 50 eggs. The smallest and largest ovigerous females recorded were 9 and 12 mm, respectively, while the largest male was 14 mm in length.

The occurrence of G. pseudolimnaeus in such a restricted area of southwestern Massachusetts, which is characterized by carbonate rich springs, suggests that the species has narrow environmental tolerances. The bulk of G. pseudolimnaeus populations occur to the north and it may be that the peripheral Massachusetts' populations represent a relict distribution. Gammarus pseudolimnaeus is presently unprotected anywhere in its range.

Decapoda

Cambarus bartonii Appalachian brook crayfish (Figure 5)

This crayfish species is the only native species of the genus Cambarus occurring in Massachusetts. Another species, C. robustus, has been introduced into the Housatonic, Connecticut, Thames, and a few coastal drainages in Massachusetts, presumably by fishermen. The two species can be distinguished using Crocker (1957) or Hobbs (1972). Crayfish of the genus Cambarus are distinguished from crayfish representing other genera in Massachusetts by the gonopod (first pleopod) of the male and by the shape of the rostrum (see Figure 5). The status of various named subspecies of C. bartonii seems to be unresolved. Specimens from Massachusetts comply with the descriptions in Crocker (1957).

Cambarus bartonii has an extensive distribution that ranges from Georgia northward and westward along the Appalachian mountains to the Great Lakes region and Newfoundland, Canada (Hobbs, 1972). The species is confined to western and northwestern drainages in New England (Crocker, 1979). In Massachusetts, the species is known to occur only in the Hoosic River drainage in Berkshire County in the northwestern most part of the state (Map 5). Collections from outside of the Hoosic River drainage and represented by specimens in the MCZ, are from Grafton (Worcester County) (MCZ 266 and 3534) and Boston (Suffolk County) (MCZ 3357). The Grafton collections are both from a spring-fed stream and the Boston collection is from the "Aquarial Garden." Both collections were made in the Nineteenth century. In recent years C. bartonii has not been found in any stream in the Grafton area. Both the Grafton and Boston records are oddities and most likely represent introductions by humans.

In the Hoosic River drainage in Massachusetts, C. bartonii is widespread and at times common. The species occurs in rocky-bottomed streams with moderate to strong current. The species typically migrates into headwaters of small first and second order streams, wherein it tunnels deeply under large, well imbricated rocks. Historically, these small stream populations, which occur up to 1550 feet (470 meters) in the hills bordering the Hoosic River valley, were interconnected by a presumably large resident population in the pre-industrialized Hoosic River.

No comprehensive life history study exists for C. bartonii. Crocker (1957) provided data on certain life history characteristics of C. bartonii in New York. Reid (1977) analyzed data gathered on C. bartonii in Maine and presented considerable information on egg-laying and seasonality of reproduction. No information presently exists for C. bartonii in southern New England. The following observations have been made on specimens collected in Massachusetts, southern Vermont, and eastern-most New York. Breeding males, otherwise known as first form males, are present during March, April, May, June, July, September, and November. Although collections for other months are either very limited or non-existent, it can be inferred that potentially reproductive males are present year round. Females with eggs or young have been rarely seen. The few available for study show the following characteristics. Two females possessing what may be considered as normal complements of eggs are 30.0 mm and 34.0 mm in carapace length and have 55 and 39 eggs, respectively. Females with eggs have been collected on 24 June, 1978; 29 June, 1978; 1 August, 1979; and 7 August, 1978, whereas the only female with young was collected on 27 September, 1982. Young crayfish (less than 10 mm in carapace length) have been observed throughout summer.

Although C. bartonii is widely distributed in the Hoosic River drainage, two reasons exist for proposing special concern status for the species. One is that the species occurs at the periphery of its range and consequently is in many ways isolated from the species principal gene pool. This problem is complicated by the fact that the historical route of dispersal into the region, the Hoosic River itself, no longer provides appropriate habitat for C. bartonii throughout much of its course in Massachusetts. Presently, the only part of the Hoosic River in Massachusetts containing both clean water and suitable habitat for C. bartonii is a short 2.4 km (1.5 mile) section extending from below the dam at Cheshire Harbor (Cheshire) to the beginning of the channelized portion in Adams. Within this short section a population of C. bartonii survives, but is isolated from all but one tributary stream (Dry Brook, Cheshire) known to contain C. bartonii. As of early 1978, (Anon., 1978) this section of the Hoosic River was classified as "B."

Further aggravating the "main stream" population in the Hoosic River, and also populations occurring near the mouth of larger tributary streams, is the presence of a widely introduced species, Orconectes virilis, a large and aggressive crayfish with a higher reproductive potential and broader ecological tolerance than C. bartonii. Orconectes virilis is possibly replacing C. bartonii through both successional and competitive processes in the river and large stream habitat. Orconectes virilis currently exists in high numbers in the "Adams" section of the river and other sections as well.

The second reason for listing C. bartonii is because the species ranges far upstream into mountainous headwaters, and because it is a very visible species with narrow environmental tolerances. C. bartonii could prove to be a valuable indicator in the region to document changes in water quality such as caused by acidic deposition.

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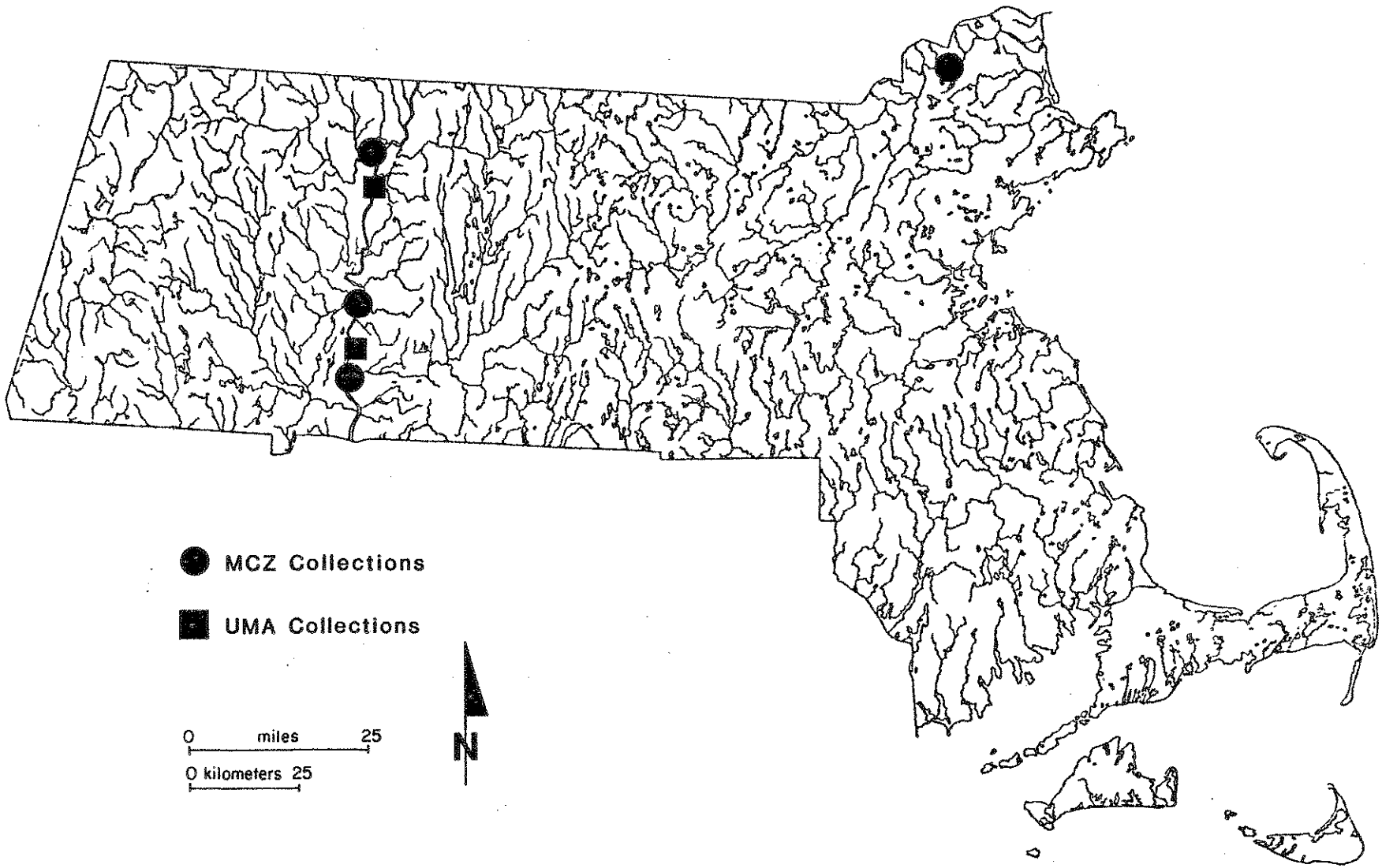
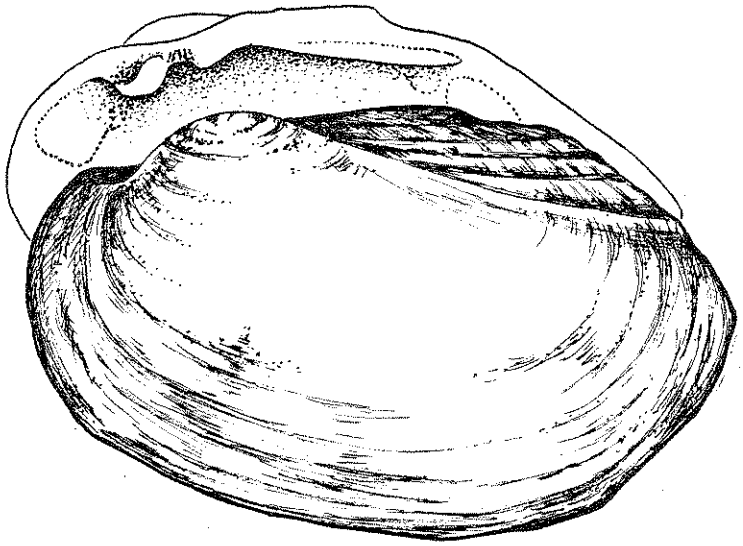
SPECIES DISTRIBUTION MAPS AND FIGURES



MAP 1. Known distribution of *Lampsilis cariosa*



a

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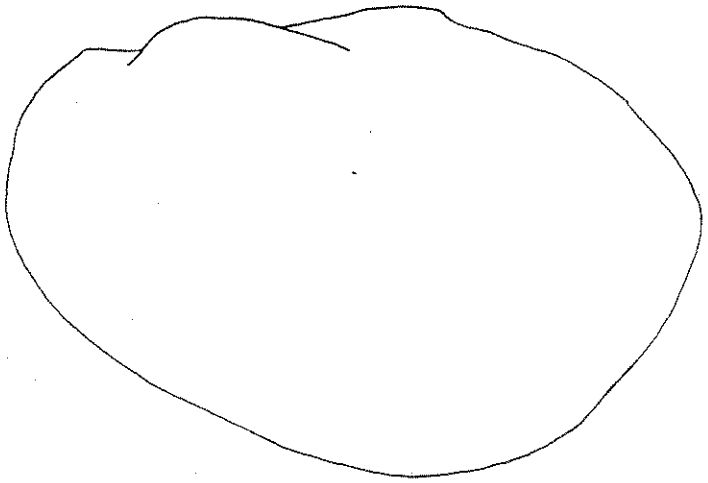
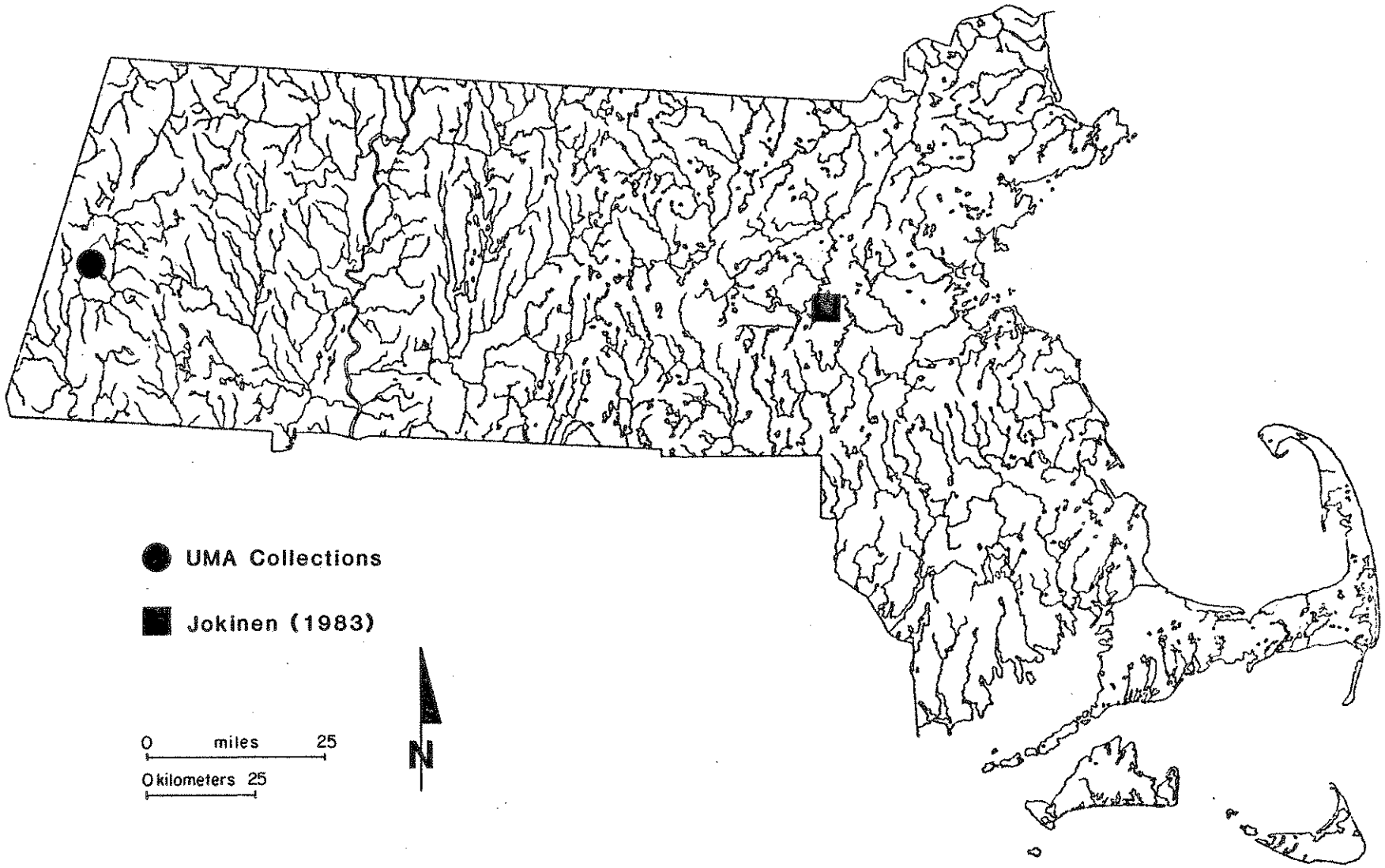


b

FIGURE 1. *Lampsilis cariosa* (shell)

a, interior and exterior of male shell
b, outline of female shell



MAP 2. Known distribution of *Valvata sincera*

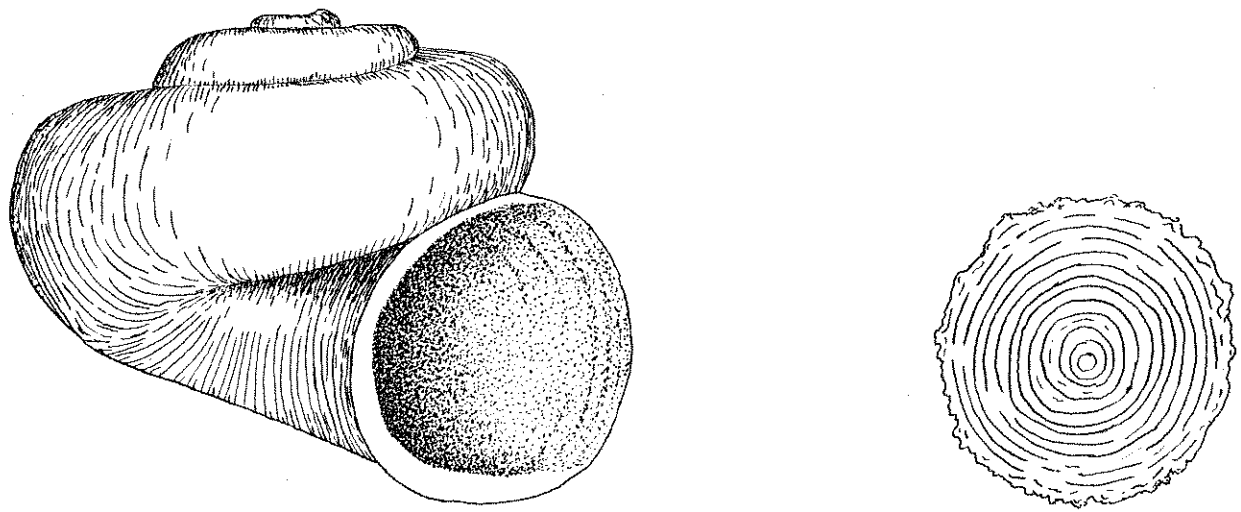
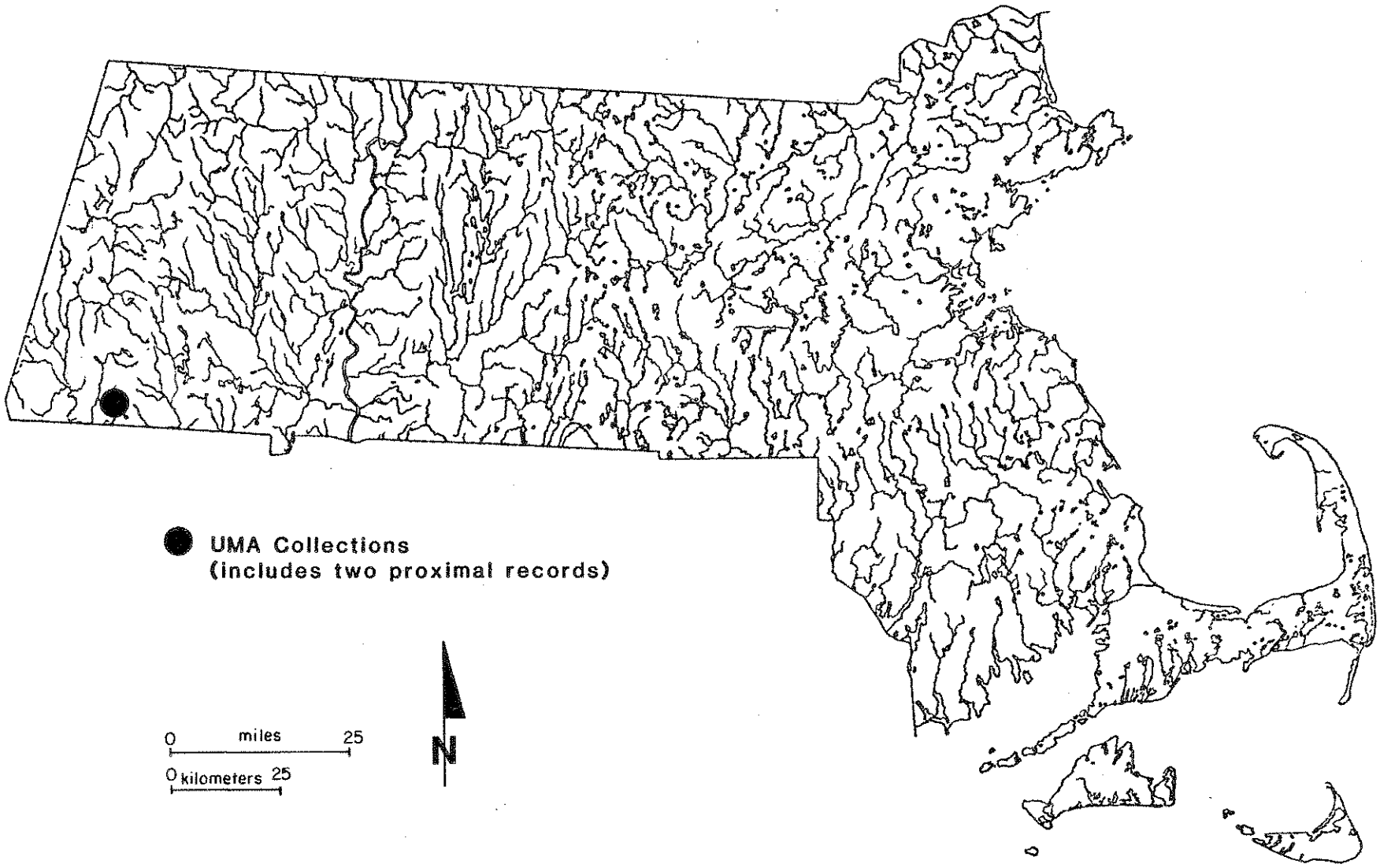


FIGURE 2. *Valvata sincera* (shell)

a, entire shell
b, operculum



MAP 3. Known distribution of *Stygobromus tenuis tenuis*

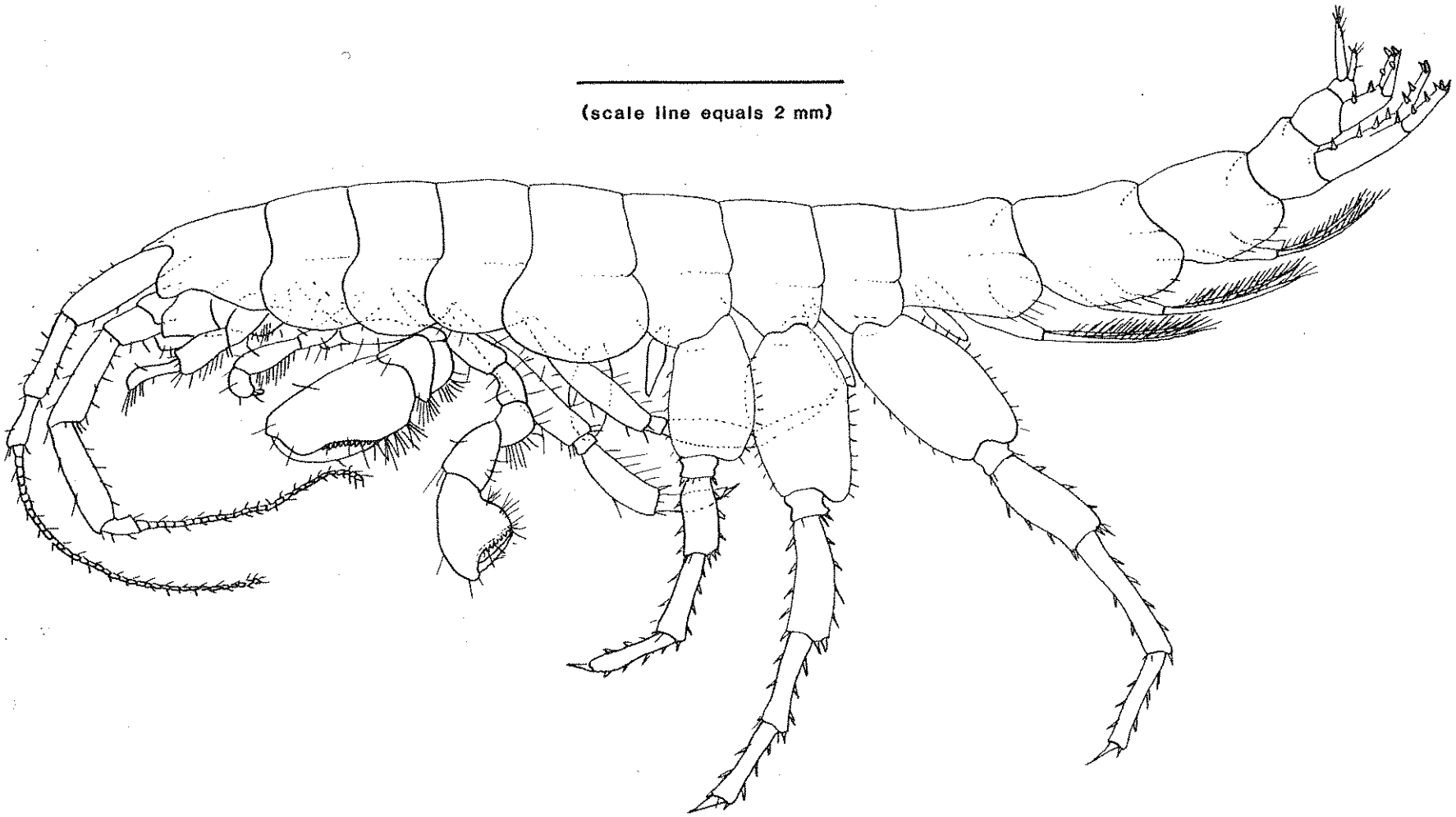
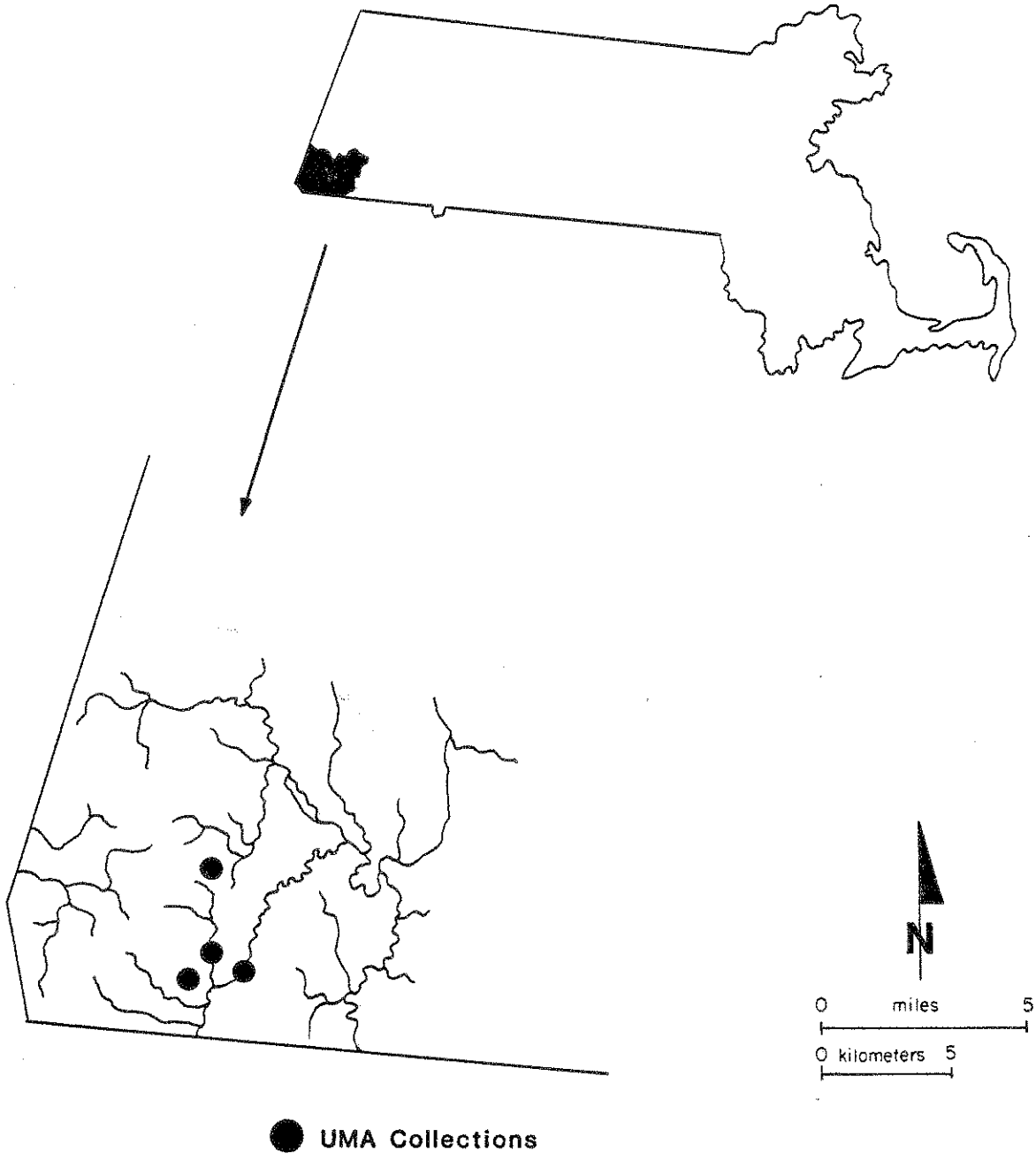


FIGURE 3. *Stygobromus tenuis tenuis* (male)



MAP 4. Known distribution of *Gammarus pseudolimnaeus*

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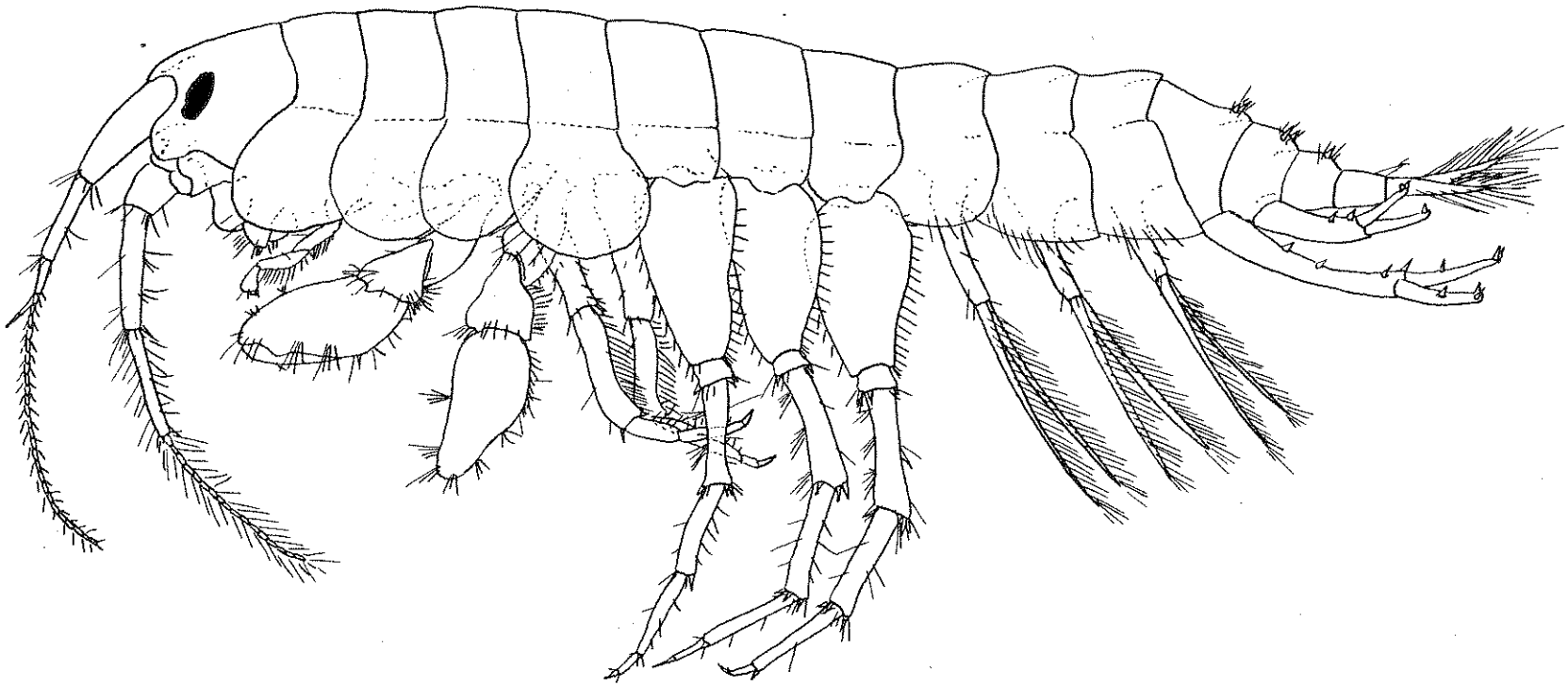
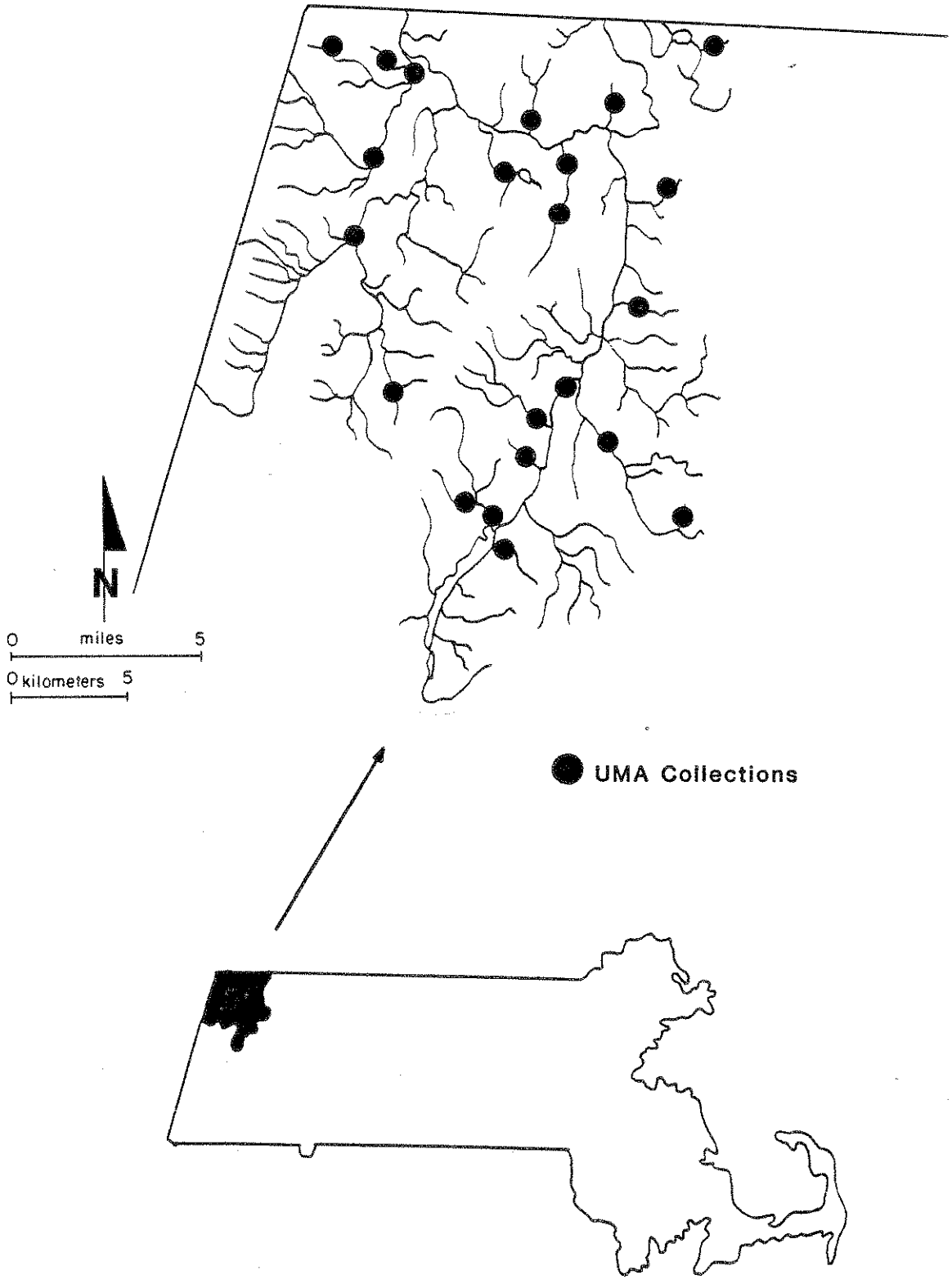
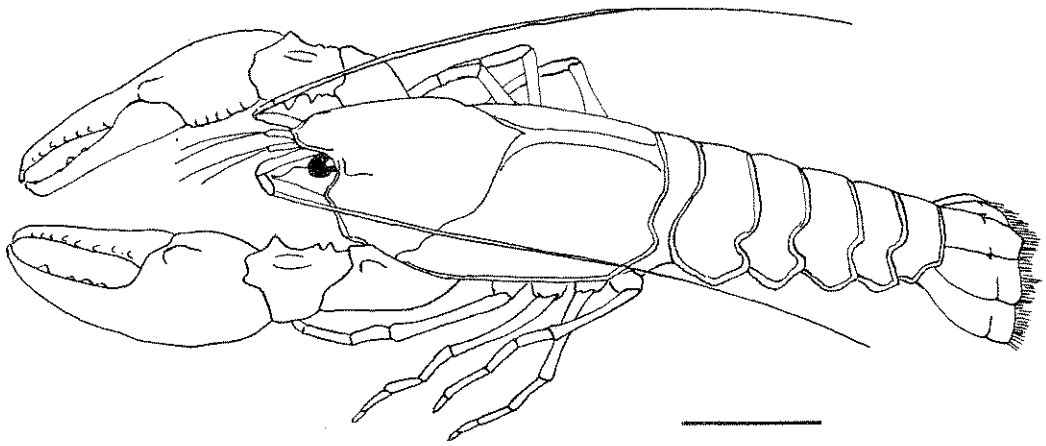


FIGURE 4. *Gammarus pseudolimnaeus* (male)



MAP 5. Known distribution of *Cambarus bartonii*



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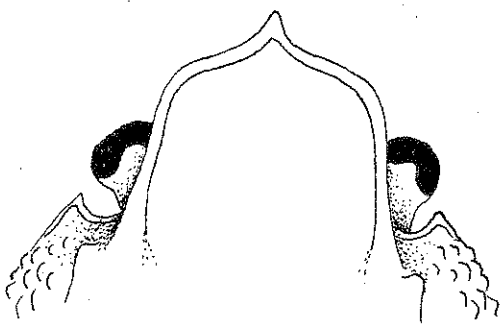
a



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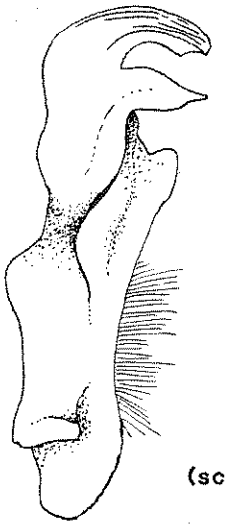
b



(scale line equals 2 mm)

c

FIGURE 5. *Cambarus bartonii* (male)
a, adult first form male
b, rostrum (dorsal view)
c, gonopod of first form male (medial view)