The Taxonomy, Distribution and Habitat of the Watermite, Feltria romijni Besseling, 1930

by

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(with 1 fig.)

TAXONOMY

Until K. O. VIETS (1955) revised the taxonomy of the *Feltria rouxi* group of species, ten different specific or subspecific names had been applied to specimens which often differed from each other in only one or two variable characters. Without reference to VIETS' previous paper (op. cit.) in which he showed that *F. rouxi batava* VIETS and *F. rouxi romijni* VIETS were the same as *F. romijni*, MOTAS et al. (1957) combined these two into a new species, *F. celtica.* They also described a male found in Romania as a new species, *F. halberti*, but the specimen differs from a typical male of *F. romijni* in only a few minor ways (MOTAS et al. 1957, p. 120). In *F. romijni* considerable growth changes occur in the adults so that the size of the genital plate and the length: breadth ratio of one individual cannot be used as a specific character unless there is a considerable range of measurements available for one species and those of the new species have a distinct, separable distribution. The authors listed these two measurements and slight differences in the shape of the genital plate, the position of the anal pore and the shape of the last segment of the third leg and its spines as the distinguishing characters of *F. halberti.* These characters are very variable in a population of *F. romijni* and the specimen of *F. halberti* is well within this range of variability (see the description in VIETS, 1955). Unless further evidence to the contrary is found, *F. halberti* should be regarded as a synonym of *F. romijni.*

If we accept the view that *F. celtica* and *F. halberti* are synonyms of *F. romijni*, there are at present no subspecies and only four species in this group. They are *Feltria rouxi* WALTER 1907; *F. romijni* BESSELING 1930; *F. bispinosa* ANGELIER 1950 and *F. conjuncta* VIETS 1955. As the differences between them are slight compared to the differences between this group and the other species in the same genus, it is reasonable to suppose that they diverged recently from the same stock.

BESSELING (1930) showed that in *F. romijni* the number of spines on the sixth segment of the male's third leg can vary in a single population and also between the left and right legs of the same individual. In Table I his data are compared with data from collections from a small stream in Wytham Woods, Berkshire, England. The two populations have a different distribution of the number of spines per leg around the mean of three. Seventeen males from other localities in England had a mean of 3 spines, although four specimens had one leg with 4 spines. As I found only one such case at Wytham, it suggests that some British populations may resemble the Limburg one rather than that at Wytham.

TABLE I.

Number of Spines.	Limburg (BESSELING 1930)	Wytham Woods.
2	0	8
3	29	41
4	3	1
5	2	0

Accepting that the different populations of this species may have a different distribution of the number of spines, let us now examine the *F. bispinosa*. ANGELIER (1950) stated that this species closely resembles *F. romijni* but that it has two distinguishing characters: 1) the anterior epimera were distinctly separated; 2) there were two spines on the sixth segment of the male's third leg. Neither of these characters can be used to distinguish this species from *F. romijni*. My observations on the females of *F. romijni* show that every form between completely fused and completely separate anterior epimera occurs amongst the females of one population. This was also observed by BESSELING (1937). In the male WALTER & MOTAS (1927) pointed to the separation of the epimera as a characteristic of *F. romijni*, distinguishing it from *F. conjuncta*. All the British males of *F. romijni* that I have examined have the anterior epimera separated. The possession of two spines on the male's third leg is not a specific character of *F. bispinosa* because the number of spines varies both between and within populations of *F. romijni*. A number of specimens of *F. romijni* which I have examined had two spines on one leg and three on the other; moreover, one specimen from the Wythan population had two spines on both legs, as in ANGELIER'S specimen. As only one male of *F. bispinosa* is known we have no idea of the variability in the males of the Pyrenean population and as this male cannot be separated from a male of *F. romijni* from Wytham Woods in England, *F. bispinosa* must be regarded as synonymous with *F. romijni*.

The *F. rouxi* group therefore contains only three species (see key). The females of *F. romijni* and *conjuncta* cannot be separated, but the presence of an anal plate and two small plates lying lateral to the glandularia distinguish these two from the female of *F. rouxi* where they are absent. As only two specimens of *F. rouxi* have been found, both females and both from near Basel, it is impossible to determine whether these characters are the result of a small genetical change in one or two populations, forming a morphological variety, or whether they indicate a distinct biological species. It is a pity that no male of *F. rouxi* has been found from the type locality as this might confirm or deny the validity of the species. None of the British females I have examined resembles *F. rouxi* in these two characters, but I have found other characters, that were thought to distinguish the female of *F. rouxi* in *F. romijni* populations in England. These characters include the straight ventral surface of P IV, the very small glandularia and the deep posterior incision. The latter characters are probably of little use for defining species, for, like the distance between the epimera (unpublished data), they probably vary according to the age of the animals.

The males of *F. romijni* and *conjuncta* are distinct (VIETS, 1955) but all the characters that separate them appear to be results of the greater thickening of the skin of the male of *F. conjuncta*. The thickening of the palps and the larger bulge on the third leg as well as the fusion of the epimera and the glandularia all suggest that a single physiological change in the development may have taken place and caused the separation of the species.

Key to the Species in the F. rouxi Group.

1. a. Genital plates fused .... 2(♂♂)
   b. Genital plates separate .... 4(♀♀)

2. a. 1st epimera fused, glandularia fused to 4th epimera, definite high bulge on the 6th segment of the 3rd leg..... *conjuncta* ♂
   b. 1st epimera and glandularia separate, slight bulge on 3rd leg .... *romijni* ♂

3. a. Anal plate present, 6 plates between epimera and genital plates .... *conjuncta* ♀, *romijni* ♀
b. Anal plate absent only 4 plates between epimera and genital plates .... *rouxi* ♀

The male of *F. rouxi* is unknown.

The variations that seem to be characteristic of this small group of species may be brought about by the species' living in isolated populations in the upper reaches of river systems, for except in one instance (FROST, 1942), the three species have always been recorded from streams and springs so that their distribution is not continuous. One such population of *F. romijni*, studied in detail and considered relatively large in comparison to others that I have examined, had approximately 250,000 individuals in 1958. The populations in different streams of the same river systems may have some exchange of genes, but there is unlikely to be any exchange at all between systems that are separated by long distances. This applies particularly to cold water forms which are prevented from moving downstream (MOTAS, 1928).

As there is a five month gap between the dispersal phase and reproduction in *F. romijni*, the initial invading population must be fairly large in order to succeed. This suggests that the genetical differences probably arose because of different mutations and selection pressures between populations and not because of the differences in the initial gene pools. Further study may show these three species to be morphological forms of the same interbreeding species that have arisen because of a discontinuous distribution.

GEOGRAPHICAL DISTRIBUTION

Figure 1 shows the distribution of *F. rouxi*, *romijni* and *conjuncta*. In some cases a number of different localities within 20 or 30 miles of each other are recorded as one spot. Except for one record from the Dingle Peninsula in Ireland, which is my own observation, all the European and Irish records are taken from the literature. There are no previous published records of these species from the United Kingdom but at the British Museum I found one slide in the SOAR collection from Beith in Scotland. This slide is of a male of *F. romijni* and the label reads '*Feltria rouxi* WALTER, Beith, June 1916, 200 F. Vol. 2'. SOAR did not include this new record in his monograph published in 1925—9 (SOAR & WILLIAMSON, 1925—9) so we must assume that it was overlooked as 'Vol. 2' seems to refer to

Volume 2 of the monograph which does include this genus. In the same collection I also found a slide of *F. minuta* from Dartmoor, England (Aug. 1917). This again was not included in the monograph even though this too was the first record from the United Kingdom.[1] Below I have listed the new localities for *F. romijni*. The records from the Windermere district are from data which T. GLEDHILL has been kind enough to send to me and the one from Northumberland is from information kindly supplied by Miss N. S. PARKER. All the other British records are from my own collection. The temperatures listed are from spot samples unless otherwise stated.

New Localities of F. romijni from the British Isles.

Berkshire.

1. Marleywood Plantation, Wytham Woods. Small, calcareous, spring-fed stream, flowing through deciduous woodland. Usually less than 1 metre wide and a few centimetres deep. No aquatic vegetation. Water temperature extremes 2—19°C, from daily records. (See also ELTON, 1956). *Tanytarsus* (*Stempellina*) *flavidulus* EDWARDS 1929 very common.
2. Stream in the Park, Wytham Woods. A small, calcareous spring-fed stream, shaded throughout most of its length by shrubs and trees, mainly hawthorn (*Crataegus oxyacantha* R.) Some silt patches. *T.* (*S.*) *flavidulus* common.
3. Cothill. Small, calcareous, spring-fed stream, shaded by trees and a thick growth of *Phragmites communis* TRIN. which in some places grows in the stream. The bottom is mainly of silt. *T.* (*S.*) *flavidulus* common.

Oxfordshire.

4. Evenden Bottom, Wychwood Forest. Small, calcareous, fast-flowing, woodland stream with a canopy of hawthorn along most of its length. No silt. Fed by water from Cyder Well. Temperature 11—11.5°C. Very shallow.
5. Stream below Wort's Well, Wychwood Forest. Very small spring-fed stream, running through a woodland glade. Bottom mainly silt. *Apium nodiflorum* abundant. *T.* (*S.*) *flavidulus* common.
6. Burford. Small, calcareous, silty, spring-fed stream running through a marshy area in a wood consisting mainly of willows. Temperature 10°C. Irises growing in the stream. Larvae in the sub-genus *Stempellina* abundant.

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[1] I would like to thank the Trustees of the British Museum and DR. G. OWEN EVANS for allowing me to examine the collections.

Gloucestershire.

7. Cranham. Fast-flowing, calcareous, spring-fed stream running through a beech wood - Buckholt Wood. The bottom has large silt patches and some gravel and stony stretches. Temperature 13.5°C. *T. (S) flavidulus* present.

Pembrokeshire, Wales.

8. Near Mathry. Small, fast-flowing stream. Bottom mainly stones and gravel but a small side branch has abundant silt. Flows through a mixed coppice. Temperature 10°C.

Co. Kerry, Eire.

9. Stradbally, Dingle Peninsula. Torrent stream, up to 1 m. deep and 6 m. wide. Large boulders and a little moss, no silt and very little gravel.

Northumberland.

10. Haltwhistle Burn, Haltwhistle. Runs off moors and cascades down waterfalls. Very strong current. Depth varies between 5 cm. and 80 cm. pH 7.2. Some moss-covered rocks. Trees (mainly willows) lining the stream. Temperature range 2.5 to 21°C.

Westmorland.

11. Dale Park Beck, Lower Park. Calcium 14 p.p.m.
12. Ford Wood Beck (Outgate). Calcium 12 p.p.m. Moorland stream; stony bed; swift current; between 15 cm. and 50 cm. deep. Temperature during the year 0—19°C. (MACAN, 1958).
13. Wilfin Beck, High Cansey.

Lancashire

14. Holbeck. Fast-flowing. Moss-covered stones and areas of gravel. Some stretches shaded by trees.

Factors affecting Geographieal Distribution

Before discussing a distribution based on so few records two points must be considered. Firstly the region is one that has been well studied and therefore the known distribution is probably a fairly close approximation to the true one; secondly its similarity to that of a number of other freshwater groups is very striking. These include the genera *Niphargus* and *Bathynella* (see THIENEMANN, 1950; EFFORD, 1959; SPOONER, 1961) *Polycelis felina* (DALYELL) (= *P. cornuta* (JOHNSON)), (see VANDEL, 1928; THIENEMANN, 1950 and

DAHM, 1958) and the subgenus *Proasellus* (W. D. WILLIAMS, in litt.).

The similarity between the distribution of the *F. rouxi* group of species and that of other species suggests not only that the known distribution is a good approximation to the actual one but also that the basic reason for a particular boundary may be common to all species. There are three possible explanations: a) climate; b) the recent history of the species; c) these two factors acting together. The historical explanation can be disregarded in most cases where the animals have good dispersal powers as they would have invaded neighbouring areas if no other barriers were present. We must therefore turn to the climate for a possible explanation of the distribution of *F. romijni.*

Climate.

The Pyrenees mark the change from the wet summers and mild winters of Northwestern Europe to the hot dry summers and cool wet winters of the Mediterranean. ANGELIER (1957) has shown that this climatic difference is associated with different communities of watermites in comparable streams. This may be explained by the higher temperatures experienced by the species living south of the Pyrenees or by the tendency for the southern streams to dry up in summer. The most southerly records of *F. romijni*, from Jugoslavia and the Pyrenees, are from springs and Moutain streams (VIETS, 1936; ANGELIER, 1950) — habitats where one might expect to find a northern aquatic species living in the warmer parts of its range.

The north-eastern limits of these animals lie along the line from Denmark to the Black Sea. This line is parallel to the winter isotherms (Fig. 1) and contrasts with the summer isotherms which run East-West in this part of Europe. The similarity in direction suggest that the north-eastern limit of these aquatic animals may be closely associated with the very cold winters. We have no idea how temperature might limit the northwards spread of *F. romijni* into a region where other species of the same genus live. The absence of *F. romijni* from Scandinavia along with a number of other aquatic species, such as *Polycelis felina*, is probably associated with the cold winters. However, VANDEL (1928) follows THIENEMANN'S view (see DAHM, 1958) in suggesting that, because western Europe became warmer sooner than central Europe, the northward migration which followed the glaciation was quicker in the West and *P. felina* was able to reach Great Britain but not Scandinavia before these countries were cut off (ca. 7000 years ago).

A more probable explanation for the present distribution of *F. romijni*, *P. felina* and the other aquatic species with a similar distribution is that they lived fairly near to the ice during the glaciation. Their proximity would have depended both on the individual species and on the magnitude of the temperature gradient away from the ice sheet. It is now accepted that when the ice reached its maximum extent there was an area of land left around the western coast of Europe resulting from a drop in the sea level caused by the quantity of water locked up in the ice sheet (GODWIN, 1956). This area would have provided a temporary refuge for the Irish fauna forced south by the advancing ice. There is also evidence that throughout the last glaciation there were ice-free areas present in Ireland which may have provided additional refuges for some of the fauna (FARRINGTON, 1947). Other ice-free areas occurred in the South of England, western Europe and south-east Europe and these were at least partly inhabited by aquatic animals. Although THIENEMANN and other have assumed that the aquatic fauna did not remain in southern England during the glaciations, there seems to be no evidence supporting this argument (BEIRNE, 1952). The recent paleobiological evidence suggests that the area was covered by tundra (GODWIN, 1956, BEIRNE, 1952); the streams in the tundra regions today are by no means barren although the number of species is low.

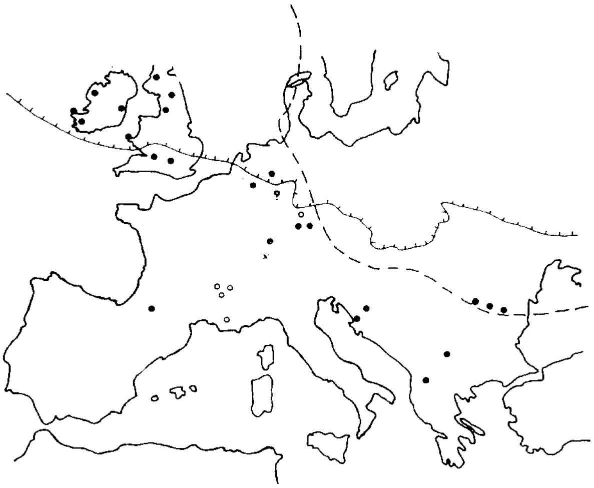

Figure 1. Geographical Distribution of the Species in the *Feltria rouxi* group. ● *F. romijni;* × *F. rouxi;* ○ *F. conjuncta;*? species uncertain. ------ O°C isotherm for January. ııııı Southern limits of the main ice sheet of the last glaciation (after WILLS (1951)).

With the retreat of the ice and the return to more temperate conditions, these animals may have moved up the river systems they inhabited, but on the whole they do not appear to have changed their distribution by more than a few miles except in Britain. The explanation for this seems to be that, on the retreat of the ice sheet, only the British Isles, of the land that was exposed, had a suitable climate for their survival. Thus, although they appear to have a relatively poor power of dispersal *F. romijni* and *P. felina* have spread as far north as central Scotland during the last 7000 years (REYNOLDSON, 1953), whereas in Europe very few records occur north of the southern limit of the glaciation. As can be seen in Fig. 1, only the British Isles and a small part of Germany and the Netherlands of the area covered by the ice now have a January mean above freezing point.

A species that is restricted to western Europe is often found to occur in another restricted region in eastern Asia and Japan, e.g. *Feltria cornuta.* It appears that this type of distribution originated when a wide-spread Palaearctic species became divided by changes in the climate which made central Asia uninhabitable. At the moment although many species of *Feltria* have recently been discovered from Japan, none of them are in the *F. rouxi* group. If the climate prevents the eastwards spread of *F. romijni* in Europe, it would not be surprising to learn that a member of the *Feltria rouxi* group occurred in east Asia.

Other Factors affecting Distribution.

In the following sections I will discuss a few of the biological and physical factors which appear to affect the local distribution of *Feltria romijni* within its geographical range.

Host.

No mention of the host of the species in the *F. rouxi* group occurs in the literature. In Wytham Woods, Berkshire, the larvae of *F. romijni* parasitized *Tanytarsus* (*Stempellina*) *flavidulus*, EDWARDS, 1929. This very small chironomid had previously been recorded from only two localities, both in England: Bedford Hills, Bedfordshire, and Cothill, Berkshire. It has never been recorded from the Continent. I collected at Cothill and found both host and mite abundant. Later I discovered the mite in streams at Wytham Woods, Wychwood Forest, Burford, Cranham near Gloucester and Mathry in Pembrokeshire. In all except the Welsh locality and Burford, the host is known to be *T.* (*S.*) *flavidulus* and at Burford larvae of the subgenus *Stempellina* are present although the species is not yet determined. In other words, *F. romijni* appears to be host-specific in at least five of the seven localities in the South of England.

In Ireland FROST (1942) studied the fauna and HUMPHRIES &

FROST (1937) studied the chironomids from two localities on the River Liffey. *F. romijni* was present in both localities, but no specimens of the subgenus *Stempellina* were found although over 35 other species of chironomids were collected. In fact the genus had not been recorded from Ireland at all until recently when I found a few larvae (sp. indet.) in a collection taken near Killarney. The few records of *F. romijni* from the Lake District again occur in an area well studied for its chironomid fauna, but the sub-genus *Stempellina* has not been recorded from the same stream as *F. romijni*, although I have collected some larvae from a calcareous stream in the region.

The indication is that *F. romijni* is host-specific in the localities studied in the South of England and either non-specific in the torrent streams of the North and West or specific on a different host. It will be particularly interesting if the species turns out to be host-specific in one part of its range and non-specific in another part.

There are three species of *Feltria* recorded from the British Isles: *F. cornuta*, *romijni* and *minuta*. *F. cornuta* is known only from one male and one female collected in the Lake District (T. GLEDHILL in litt.) and *F. minuta* is the most common of the British species. The distribution of *F. minuta* contrasts with that of *F. romijni* in being Holarctic. The distribution of the two species must have originated when the present restricting influence of the temperature on *F. romijni* was absent. It is therefore interesting to consider why the area of distribution of one species is so much greater than that of the other. I looked briefly into the ecology of *F. minuta* to try to find a possible reason for the difference.

F. minuta occurs mainly in fast-flowing mountain streams but is sometimes found in fast-flowing lowland streams and springs. In some localities it has been found with *F. romijni* (FROST, 1942). The main difference between the two species is that *F. minuta* is a cold stenothermal form and *F. romijni* is less so. This is well illustrated by my collection of the two species together at Cyder Well, Wychwood Forest. This spring gushes from the rock and the stream flows about 200 metres through a wood before running into a pond. *F. minuta* was collected only from the actual spring and 10 metres below, whereas *F. romijni* was not collected in the first 10 metres but was found in the rest of the stream.

I obtained from T. GLEDHILL some insects he had collected in emergence traps set in a stream where *F. minuta* lived. The larvae of this species were parasitic on a number of different species of chironomids. More recently in a collection from Ballysmuttan in the Wicklow Mountains, Eire I found a number of the larvae of *F. minuta*; some were free-living, one was parasitic on a pupa of a chironomid and one was attached to the intersclerite membrane on the ventral side of the neck of a nymph of *Protonemura meyeri* PICTET (Plectoptera). The most surprising find, however, was a single caddis larva[1] parasitized by 34 larvae of *F. minuta* and one larva of *Lebertia* sp. There are very few records of watermites parasitizing stoneflies and this appears to be only the third record of mite larvae on a caddis (VIETS, 1923; MOTAS, 1928).

This brief comparison shows that there are two distinct differences in the ecology of these two species of *Feltria* that may account for the present differences in their range. Firstly *F. minuta* prefers colder water and secondly it is not host-specific. The preference for colder water may account for its widespread distribution in Asia and North America, in regions that experience temperature too low for *F. romijni*, and its occurrence in a large number of localities in a region may be the result of its having numerous hosts and thereby greater dispersal powers and greater choice of habitats.

Current and Altitude.

The general structure of the genus is typical of mites from fast-flowing streams. The body is small and dorso-ventrally flattened and the legs are short, robust, lack swimming hairs and have well developed spines and claws. The flattened body allows the animal to get into protected spaces between stones and the strong legs and claws are probably adapted to enable the animal to retain its position against a strong current. It is not surprising to find that the one factor common to all the localities where species of the *F. rouxi* group occur is the presence of flowing water. In most cases the localities are small or medium sized streams, but some are springs and one is the River Liffey at Straffen where it is about 36 metres wide and up to 2 metres deep (FROST, 1942). In a detailed study of a small slow-flowing stream I found that *F. romijni* occurred mainly in the places where the stream was flowing comparatively quickly. Recent studies of aquatic animals seem to point to respiratory exchange as one of the main actions of a flow of water over the body, rather than the high oxygen content of flowing water as was previously thought (RUTTNER, 1953). MOTAS stated that the streams where *F. conjuncta* occurred were highly oxygenated but, as ODUM (1959) pointed out, this is so in most small streams. In the laboratory I have kept specimens of *F. romijni* in covered petri-dishes for over two months at temperatures that fluctuated around 20°C. Although the oxygen supply must have been at a fairly low level during this time neither it, nor the high temperatures, appeared to have any effect on the activity of the mite. I cannot explain the discrepancy between the

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[1] It is unfortunate that further determination of these specimens is at the moment impossible.

laboratory and field observations but, as WELCH said (1935) an animal may live under conditions in the laboratory that it would never select in the field.

MOTAS (1929) stated that *F. conjuncta* occurs in fast-flowing streams of the plains and lower mountains, and SOAREC (1942) said that she found *F. romijni* at low altitudes, where it was abundant at the foot of mountains and hills. *F. romijni* has been collected from just above sea level to 2100 metres (SOAREC, 1942). It has never been collected from high mountains in Europe which supports the hypothesis that the north-eastern geographical limits are associated with temperature.

Water Temperature.

F. rouxi has been recorded from only two localities, both near Basel in Switzerland. On the basis of these two collections both WALTER (1907) and BORNHAUSER (1912)unjustifiably described this species as cold stenothermal. THIENEMANN (1910) also described '*rouxi*' as cold stenothermal, basing the statement on one collection he made and on WALTER'S records. The identification of THIENEMANN'S specimen is uncertain. SOAREC (1942) described *F. romijni* as cold stenothermal after a number of collections from different localities where the temperature ranged between 5 and 14°C. On the other hand MOTAS (1929) described *F. conjuncta* as eurythermal and stated that it is usually found in streams that reach 18°C or more during the summer. Both FROST (1942) and MACAN (1958) published temperature records from streams where *F. romijni* occurred and their data supports MOTAS as the streams reached a temperature as high as 20°C during the hottest period of the year. PARKER (in. litt.) also records a range of 2.5—21°C. for a stream where *F. romijni* occurred and D. H. ECCLES (unpublished) showed that one of the streams in Wytham Woods has a similar temperature range.

F. romijni cannot be classed as either stenothermal or eurythermal as the tolerance range extends between the two extremes. It does not live under conditions where it experiences the extreme temperature range of a eurythermal species in ponds and lakes where the summer temperature may reach 26°C or more, but it has a wider tolerance range than the typical stenothermal mites like *Hydrovolzia placomorpha*, *Arrenurus fontinalis* and *Bandakia concreta* which are found only in or very close to springs. RUTTNER (1953) pointed out that there is every gradation between a typically eurythermal animal and one that is stenothermal. The tolerance range of *F. romijni* is nearer to the eurythermal end of the scale but the preferred temperature seems to be low. Whether this would be true if the reproductive requirements of the species had also been considered, as RUTTNER suggested in his supporting diagram, will remain an open question until the physiology of the species has been studied.

On the continent *Feltria romijni* has been recorded from a number of springs but in six of the streams I have studied it occurs below, but not actually in the spring. In two cases the springs are inhabited by *F. minuta* and in another by *Bandakia concreta* and *Arrenurus fontinalis.* I cannot explain why *F. romijni* was not found in the other springs where porohalacarids but no other watermites occur. Possibly *T.* (*S.*) *flavidulus* cannot live in springs while on the continent of Europe *F. romijni* may parasitize a different host that does inhabit springs.

Vegetation.

All the streams in which *F. romijni* occurred in the South of England were in woodland or were shaded by trees or by a dense growth of *Phragmites communis.* In some localities in Ireland, however, (e.g. Ballysmuttan, Stradbally, and Croaghpatrick) the streams are completely exposed. There are at least three ways in which the trees could affect the mite population: by keeping the stream cool; by providing food indirectly in the form of leaf litter; and by supplying a suitable environment for the adult host. The first two factors could also affect the mite through the host.

MACAN (1958) has shown that the shade provided by trees can reduce the temperature of a stream by as much as 7.6°C compared with an otherwise similar but unshaded stretch. The trees which prevent the water from reaching temperatures above the tolerance range of the species during hot weather may be the limiting factor allowing either *F. romijni* or *T.* (*S.*) *flavidulus* or both to live in a particular stretch of stream.

If the leaf litter that falls into woodland streams is from trees with soft leaves, such as ash (*Fraxinus excelsior* L) or sycamore (*Acer pseudoplatanus* L), it is broken down by the action of detritus feeders like *Gammarus pulex* and *Nemoura erratica.* The leaves of other trees such as beech (*Fagus sylvatica* L) and oak (*Quercus robur* L) are not easily broken down. The fine detritus produced by the breakdown of the leaves provides food for the smaller detritus feeders, such as the chironomids which are probably unable to feed on the whole leaves because of their small mouthparts. The food of *F. romijni* is unknown but its size and mouthparts suggest that it eats small animals, such as the smaller detritus feeders or eggs and therefore the amount of leaf fall and the number of large detritus feeders affect the food supply of the populations. The absence of trees may affect the numbers of *F. romijni* by reducing the food supply of the host or by causing its complete absence. FROST'S data on the Ballysmuttan locality and my own from Stradbally suggest that in some localities the complete absence of trees is associated with the absence of species in the subgenus *Stempellina*. In acid streams like those at Ballysmuttan and Stradbally, where the flow is very fast there are no patches of silt where *T. (S.) flavidulus* could live. Most of the fauna is restricted to clumps of moss and the underside of stones. In this type of habitat *F. romijni* is nearly always recorded from the moss, and it seems likely that the larvae, hatching from eggs laid in clumps of moss, parasitize a host that pupates there. The low pH and the exposed position may also exclude *T. (S.) flavidulus* from this type of stream. My observations on the swarming behaviour of *T. (S.) flavidulus* (EFFORD, 1961) suggest that swarming would not occur in exposed conditions of the Irish locality.

I have attempted to study in more detail the effect of trees on the distribution downstream from the woodland region. Unfortunately it is only in one locality, at Cranham, that the stream passes out of the woods before it changes its nature. I made a collection about half a mile below the woods in an apparently suitable habitat but found no adults or nymphs of *F. romijni* and only one larva (which might have been washed downstream from the wooded area), although there were large numbers of mites of other species present. At Burford there are three springs spaced out along the edge of a hill, two in the open – one large and one small – and one of medium size in the woods. *F. romijni* was found only in the stream below the woodland spring.

At the moment more information is needed about the effect of the tree canopy on the distribution, but the available evidence suggests that the trees do play some part in making the stream favourable for *F. romijni* in the localities in the South of England.

Hydrogen Ion Concentration.

pH apparently has as little effect on *F. romijni* as it has on any other watermite for this species has been recorded from both acid and alkaline water. (VIETS, 1933; FROST, 1942). The pH may nevertheless have a definite influence on the distribution of the mite either through its food or through its host. The absence of *T. (S.) flavidulus*, the host, from the northern and western localities in Britain is possibly associated with the pH, as these localities, except for the lower part of the Liffey, are all acid streams whereas the southern ones are alkaline. MOTAS (1928) recorded *F. conjuncta* from the highly calcareous streams in south-east France and *F. rouxi* (WALTER, 1907b) has been found in a similar habitat.

SUMMARY

1. There are at present three species within the *Feltria rouxi* group. These are *F. rouxi* WALTER 1907, *F. romijni* BESSELING 1930, and *F. conjuncta* K. O. VIETS 1955. *F. halberti* MOTAS et al 1957, *F. celtica* MOTAS et al 1957 and *F. bispinosa* ANGELIER 1950 should be regarded as synonyms of *F. romijni*.

2. Fourteen locality records of *F. romijni* in the British Isles are listed and the geographical distribution of this species is discussed. The geographical limits coincide with isotherms and it is suggested that the spread of this species is prevented by some factor associated with the low winter temperatures in the North and East and with the high summer temperatures in the South.

3. *F. romijni* is host specific on *Tanytarsus* (*Stempellina*) *flavidulus* EDWARDS 1929 (Chironomidae) in six streams in the South of England. The host has not been recorded from other localities in Europe and the available evidence suggests that *F. romijni* may have another host in Ireland (River Liffey) and probably elsewhere.

4. *F. minuta* is much more widespread than *F. romijni*. Three ecological factors are noted which could account for this: 1) *F. minuta* is not host specific, parasitizing species of Chironomidae, Trichoptera and Plecoptera; 2) it is cold stenothermal and 3) it is found more frequently in mountain torrents.

5. In the South of England the distribution of *F. romijni* appears to be closely associated with the presence of thick vegetation lining the streams or a canopy of trees over the stream. In Ireland it occurs in streams which are completely exposed. The vegetation may affect the distribution of the mite by lowering the temperature of the stream or altering the distribution of the host.

6. In the British Isles *F. romijni* is mainly found in two types of habitat, in the moss clinging to the stones in torrents, and on the bottom of small, slow-flowing, deciduous-woodland streams. The temperature range of the streams in which it lives is usually between 2 and 20°C although it is mainly found in the cooler parts of the stream, especially near a spring.

ZUSAMMENFASSUNG

1. Gegenwärtig sind drei Spezies in der *Feltria rouxi* Gruppe bekannt. Es sind dies *F. rouxi* WALTER 1907, *F. romijni* BESSELING 1930 und *F. conjuncta* K. O. VIETS 1955. *F. halberti* MOTAS et al. 1957, *F. celtica* MOTAS et al. 1957 und *F. bispinosa* ANGELIER 1950 sollten als Synonyme von *F. romijni* betrachtet werden.

2. Vierzehn Fundorte von *F. romijni* auf den Britischen Inseln werden mitgeteilt; die geographische Verbreitung der Art wird diskutiert. Die geographischen Grenzen stimmen mit den Isothermen überein, und es ist denkbar, dass die Verbreitung der Art durch niedrige Wintertemperaturen im Norden und Osten und hohe Sommertemperaturen im Süden sowie durch andere Faktoren verhindert wurde.

3. In sechs Strömen Südenglands ist *Tanytarsus* (*Stempellina*) *flavidulus* EDWARDS 1929 (Chironomidae) spezifisches Wirtstier von *F. romijni*. An anderen Fundorten Europas ist ein Wirtstier nicht beschrieben worden. Die vorliegenden Unterlagen deuten darauf hin, dass *F. romijni* in Irland (River Liffey) oder anderenorts ebensogut ein anderes Wirtstier besitzen könnte.

4. *F. minuta* ist viel weiter verbreitet als *F. romijni*. Drei ökologische Tatsachen könnten hierfür sprechen: 1) *F. minuta* besitzt kein spezifisches Wirtstier, sie parasitiert auf Arten von Chironomiden, Trichopteren und Plectopteren; 2) sie ist kalt-stenothermal und 3) sie wird häufiger in schnell strömenden Gebirgsgewässern gefunden.

5. In Südengland scheint die Verbreitung von *F. romijni* eng mit dem Vorkommen dichter Ufervegetation oder Baumüberhang über dem Wasser verbunden zu sein. In Irland kommt die Art in Gewässern vor, die völlig offen sind. Es könnte sein, dass die Umgebungsvegetation die Verbreitung der Milbe durch Temperatursenkung des Wassers oder Änderung der Verbreitung des Wirtstieres beeinflusst.

6. Auf den Britischen Inseln wird *F. romijni* hauptsächlich in zwei Biotopen gefunden: In überfluteten Moosen in Gebirgsbächen sowie am Grunde schmaler, langsam fliessender, durch Laubwald führender Gewässer. Die Temperatur der Gewässer, in denen die Art lebt, liegt gewöhnlich im Bereich zwischen + 2 und 20°C, hauptsächlich jedoch im kühleren Bereich und besonders in Nähe einer Quelle.

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