

**RECORDS
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**THE BIOLOGY OF *FORCIPULA TRISPINOSA*
(DOHRN) (DERMAPTERA : LABIDURIDAE)**

By

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सत्यमेव जयते

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INTRODUCTION

Biology of earwigs is a fascinating and interesting study. The review of literature, reveals that although the economic importance of earwigs has been worked out yet the biology of the insect (except a few species) has remained unexplored.

Earwigs remain mostly in concealment. They are omnivorous and most characteristic feature of their biology is the parental care that is exercised for the protection of the eggs and the young ones.

The European earwig, *F. auricularia* has received the attention of many workers including economic entomologists. Detailed investigations on the life-history and biology of *F. auricularia* has been undertaken by European and American Workers. Although its biology has been extensively studied, much confusion exists regarding, aspects of its ecology and biology. The results of European and American workers differ considerably. Hence Behura (1956) carried out detailed investigations on the life-history of *F. auricularia* and solved some controversial problems.

The European Earwig has a wide range of distribution. A native of Europe, it is abundant in the Shetland, Faroe Islands, Iceland and western Asia, including the Caucasus, Asia Minor, Syria, Iran and U.S. S.R. It has been introduced into various other countries such as North America, South America, the East Indies, New Zealand, Tasmania, Australia and Japan (Fulton 1924 ; Takahasi 1926 ; Bey-Bienko 1936 ; Tuxen 1938 ; Crumb, et. al. 1941).

Henriksen (1937) included India also in the range of *F. auricularia*. But Dr. Burr and Dr. Hincks (authorities on Dermaptera) informed Behura that they had no knowledge of the occurrence of *F. auricularia* in India.

Brindley (1914a) mentioned many points of interest about the breeding of *F. auricularia* and Chapman (1917) covered some features and early stages of the life-history of *F. auricularia* and again in 1917 (a) he added further notes on earwig. Takahasi (1926) gave notes on the life-history and habits of *F. auricularia* in Japanese. English abstract on this

was given by Goda in 1928-29. Worthington (1926) dealt with the life cycle of *F. auricularia*. Beall (1932) described the life history and behaviour of *F. auricularia*. Burr (1939) published notes on earwigs ("Modern work on Earwigs" *Sci. Prog.*, 34(133): 20:30. "Our neglected earwig" *Microscope*. 3: 29-31). Crumb, Eide and Bonn (1941) dealt with the bionomics and life history of *F. auricularia*. Fox Wilson (1942) gave a note on the invasion of houses by earwigs and ants. Castel-Branco (1945) described biology of *F. auricularia*. Guppy (1946-47) gave results of a seasons study of *F. auricularia*. In 1950 Behura gave life history and behaviour of the European earwig and again in 1956 gave results of his detailed investigations on the life history of *F. auricularia* with a view to solve some of the controversial issues or to confirm some of the conclusions already put forward. Brindley in 1912 and again in 1914 gave notes on the proportion of sexes of *F. auricularia*. Callan (1941) gave a notes on sex determining mechanism of the earwig *F. auricularia*. Fox Wilson (1940) gave note on the sexual ratio of *F. auricularia* Fulton (1924) published some habits of earwigs and he again in 1927 gave notes concerning some published statements on the habits of *F. auricularia*. Sullivan (1943) carried survey at Inistrahull and published notes on the habits of common earwig. Morgan (1926) and Burr (1939a) described Gynandromorphism in earwigs and Quadri (1937) described Gynandromorphic *F. auricularia*. Lhoste (1942a) described heterocircus *F. auricularia*.

Some other authors also contributed to the knowledge of the European earwig *F. auricularia* which are as follows :

De Geer (1773), Camerano (1880), Kerville (1907), Verhoeff (1912), Weyrauch (1929). Guppy (1950) described biology of *Anisolabis maritima* and Giles (1953) gave notes on the biology of *Anisolabis littorea*.

Besides the Biology and life cycle, earwigs have received the attention of a number of economic entomologists.

In 1918 Jones published a paper on the European earwig and its control in an *Agricultural Bulletin of U.S. Dept.* Brindley (1918) gave notes on certain parasites, food and capture by birds of the common earwig. In 1920 he gave further notes on the food plants of the common earwig (*F. auricularia*) and listed seventy-four species of plants, including garden vegetables, flowers, fruits and weeds. Fulton (1924) published notes on the European earwig. Tillyard (1925) published notes on the insects in relation to New Zealand's food supply and regarded *F. auricularia* as major pest in New Zealand. Brothers (1930-31) gave notes on the common earwig. Dimick and Mote (1934) gave a note on the present status of European earwig. Markham and Smith (1949) carried out studies on the "turnip yellow mosaic virus" and discovered that this

virus, affecting cruciferous plants in Great Britain, is capable of transmission by *F. auricularia*. Behura (1950a) published a note on the common earwig *F. auricularia* as food of little owl.

No serious attempt has been made so far to study the biology of any Indian species of Dermaptera. Keeping this fact in view it has been proposed to undertake this type of study on one of the species found in this region, called *Forcipula trispinosa*. Detailed investigations on the habitat, habits and behaviour, parasites (if any), food and feeding, gynandromorphism and regeneration, sex ratio, seasonal history in the field and laboratory, were undertaken with a view to explore these problems.

Forcipula trispinosa was recorded previously from Nepal : Chitlong Pharping, Kumaon : Bhimtal, Nainital, Bengal : Calcutta. It is also found in Burma, Iran and Bhutan.

Studies made (by the author) during the last few years, indicate that this species offers sufficient scope for working out its biology. It has been found that this is a semiaquatic species and loves excessive moisture. It is found under stones at the edge of hill streams, lakes and ponds of Nainital region.

The author recorded this species from Nainital, Bhowali, Gethia, Jeolikote, Khairna, Ratighat, Kainchi, Bhimtal and Ramgarh regions in Nainital district, Ranikhet (Almora) and Pithoragarh. All specimens were collected from the edges of hill streams except those from Nainital which were collected from the edges of the Naini Lake.

The species is nocturnal in habit avoiding strong light of the day, sheltering under stones.

It is carnivorous, feeding on insects which are caught with the help of its forceps.

For this investigation, best collection in the field has been made from Nainital Lake and the two hill streams-Khubighat Gad and Kuria Gad near village Gethia and a hill stream near Beerbhatti.

All of these hill streams are situated within two to four miles from the Nainital. Pairs and gravid females were collected in the field and reared in the laboratory in the Department of Zoology at D.S.B. college, Nainital.

SYSTEMATICS

Super family	CARCINOPHOROIDEA
Family	LABIDURIDAE
Sub family	LABIDURINAE

Forcipula trispinosa (Dohrn)

1863	<i>Labidura trispinosa</i>	Dohrn, <i>Stettin. Ent. Ztg.</i> , 24 : 310.
1900	<i>Forcipula trispinosa</i>	Bormans, <i>Das Tierreich</i> : 30
1910	<i>Forcipula trispinosa</i>	Burr, <i>Fauna Brit. Ind. (Derm.)</i> : 92
1924	<i>Forcipula trispinosa</i>	Chopard, <i>Rec. Ind. Mus.</i> , 26(i) : 89
1961	<i>Forcipula trispinosa</i>	Bharadwaj, <i>et. al. Zool. Anz</i> ; 167(7-8) : 283
1968	<i>Forcipula trispinosa</i>	Gangola, <i>Entomologist</i> , 101 : 57

Burr's (1910) description of *F. trispinosa* is as follows : "Of medium size ; general colour black with dense yellowish pubescence. Antennae typical tawny. Head black. Pronotum black the sides tawny, square. Elytra exceedingly finely punctulate, nearly smooth ; black with yellowish pubescence. Wings smooth and black, the tips yellowish. Legs uniform tawny. Abdomen deep blackish chestnut exceedingly finely punctulate, posterior border of each segment milled ; sides of segments three to five in the male with a distinct sharp slender spines ; in the ♀ with two spines but no tubercles. Last dorsal segment square, smooth, with a deep median impression ; posterior margin truncate in male, simple but milled in female, with a blunt tubercle over the root of each branch of the forceps. Penultimate ventral segment square. Forceps long and branches in male remote at the base, trigonal, straight for about two-thirds of their length with a long sharp spine on the inner margin about the middle of the straight part ; at two thirds of their length they are bent in and armed with a second sharp tooth ; beyond this they are straight to the points, which are hooked inwards. In the ♀ the branches are sub-contiguous, stout, trigonal, gradually tapering and straight. The inner margin crenulate and a small sharp tooth just before the apex which is hooked."

	<i>Male</i>	<i>Female</i>
Length of body—	20 mm.	10-14 mm.
Length of forceps—	12 mm.	5.5-6 mm.

The author found much larger specimens during his present study, in Nainital region. Males were 15 to 22 mm. long with Forceps 7.7 to 15 mm. Females measured 20 to 28 mm. in body length with Forceps 5 to 6 mm.

Gangola (1968) adds further to the description—

"Head and pronotum hairy. Tegmina smooth with shallow depression running on either side of sutural margin. Wings uniformly dark. Abdomen broader caudal. Ultimate tergite transverse, sloping in middle. Forceps with inner margin crenulated up to half the total length.

Genitalia—Parameres thin apically pointed ; with epimerites ; basal vesicle placed at base ; preputial sacs longitudinally parallel, fused at base ; mid rib well marked.

Female—Abdomen regulose ; inner margin of forceps crenulated with two to three rows of spines.”

According to Burr (1910, *Fauna Brit. Ind.*, : 92) “There is a form occasioned by stunted growth or defective nourishment, in which the wings are not developed ; the forceps are nearly straight, merely gently undulated, the teeth obsolete, the first abdominal spine almost or entirely obsolete. To this we may give the name minor, though it is hard to say whether it is an ill-developed form of this species or of *Forcipula pugnax*.”

During the present study on the life history of *F. trispinosa*, the author found a large number of such males with straight forceps and obsolete teeth. It has now been confirmed that these are certainly the ill developed forms of this species. The defective nourishment is not the cause of this type of forceps formation. The author fed the nymphs daily till the adults emerged after the last moulting.

Some variations in the development of abdominal spines were noted in adult specimens.

HABITAT

Earwigs can be found anywhere. Many a species may be found under stones, some under dead leaves, bark of trees or other damp places. Sometimes they visit human habitat. They are cosmopolitan and are found up to an elevation of 8000 ft. in Alps. In Himalayas they are a common feature up to a considerable elevation.

No earwigs are truly aquatic but Burr (1910) quotes “Dr. Annandale having found *F. decolyi* under stones at the edges of mountain streams,....” Species of *Forcipula* are known to frequent damp places. In the Nainital region where the present study was carried out, the author found a large number of specimens of *Forcipula trispinosa* under stones at the edges of hill streams, ponds and lakes.

The members of the species prefer a situation where there are numerous stones and excessive moisture and for this reason edges of hill streams, ponds, lakes are ideal places.

A few specimens were taken from gardens and waste land during rains but none of them could be collected in summer.

A number of animals, associated with *F. trispinosa*, were found under stones which include, various species of spiders, earth worms, cock-roaches

and sometimes centipedes. A species of earwig, *Nala nepalensis* (Burr) was found commonly associated with them.

In the laboratory, when the specimens were kept in dry condition, it was found that the death rate was very high. It appears that water-vapours, lost through the large area of body wall was considerable, under dry condition. So a moist environment is essential. Animals were kept for some hours in dry condition, in summer and when water was provided to them by putting a piece of water-soaked sponge, inside the jar, they started sucking water and plunging their mouth parts in the sponge. It appears, water plays an important role in the life of this species.

HABITS AND BEHAVIOUR

As in other earwigs, the negative phototaxis is well developed in *F. trispinosa* and is nocturnal in habit. The author has never found specimens of this species active by day, under normal conditions.

Many species of earwigs are attracted to light like moths. Burr (1910) states that "Mr. Green has collected a good number of species in this manner." Burr (1910) also holds that Dr. Annandale has recorded that *Labidura lividipes* is attracted to light during hot weather and rains. The common European *Forficula auricularia* Linn. ; has been recorded by Collinge (1908) to fly into houses through the windows in England, in considerable numbers on dark sultry evenings in June and July.

In Burr's (1910) Fauna of British India there is a record that the members of *F. trispinosa*, attracted by light were collected from Calcutta. But during the present study in Nainital region the author has never seen earwigs of this species attracted to the light during night.

The nymphs are more active than the adults. When disturbed, the nymphs, scuttle rapidly to the nearest place of safety, under stones or crevices between stones.

Many species of earwigs quickly sink into the water and are incapable of swimming. *A. maritima* is able to swim freely in water (Essig, 1942, and Bennett, 1904) while *Anisolabis littorea* quickly sinks in sea-water (Giles, 1953). Burr (1910) quotes "Dr. Annandale recorded *Forcipula decolyi* swimming freely in water." The author during the study found that *F. trispinosa* is also capable of swimming in water. Adults and nymphs when forced towards stream or thrown into the water swam rapidly on to the surface.

The forceps are used as organs of offence and of defence. A slight disturbance causes the upraising of the abdomen and the animal

opens forceps, widely in a threatening manner. Due to flexibility of abdomen forceps can be brought to hold at any plane. The abdomen may be turned until the forceps come on a vertical plane. The earwig then moves sideways with its widely opened forceps to attack the enemy. Sometimes the abdomen may be turned so curiously that the tip of forceps are just about to touch the head. Burr (1910) states that "A number of interesting notes have been collected by Gadeau de Kerville, on the function of the forceps. He writes that they are used as weapons for offence and defence, but not during copulation. The insects occasionally use them to fold and unfold their wings." Terry (1906) never saw *Chelisoche morio*, using its forceps in this manner. He writes that folding and unfolding of wings is a very rapid process but quite independent of the forceps. The author of the present work neither found the folding and unfolding process of wings in the earwig *F. trispinosa* nor did he find forceps helpful in this manner.

The author has found that the adults *F. trispinosa* are capable of giving strong painful nip with the forceps, though the forceps did not pierce the skin of author's fingers. Burr (1910) states that "Gadeau de Kerville was nipped by *Forficula auricularia* so strongly that blood was drawn and commander J.J. Walker had the same experience in New South Wales, from the largest known earwig *Anisolabis colossea*." Baer (1904) has found *Apterygida linearis* in Argentina, capable of raising inflammation. Burr was nipped in the same manner by a female *Labidura riparia*.

In the laboratory the author of the present work found that occasionally the forceps are used for lifting up the abdomen of the female during copulation, to facilitate effective juxtaposition, when the female is not active (usually female herself raises the abdomen whenever the male tries to copulate).

A cleaning routine was found, by the earwigs of species *F. trispinosa*, especially after feeding. Whole body surface is brushed over with lower surface of the tarsi of the legs. The mouth parts are brushed quickly by the forelegs with forward sweeps. Whole head is brushed by turning the head to a side, towards the leg, by which it is washed. Upper surface of abdomen and forceps are brushed with the help of the tarsus of the hind legs with backward sweeps. Tarsi are often cleaned by the jaws, to remove any adherent particle of food material or sand. Proximal end of one of the antennae is placed between the mandibles and maxillae and it is straightened out and is withdrawn. This process is repeated many times with each antennae.

Giles (1953) working with *Anisolabis littorea*, also recorded this cleaning routine.

In the laboratory, the author found that freshly hatched nymphs of *F. trispinosa*, also show the same type of cleaning behaviour, as soon as they come out of the eggs.

A peculiar manner of cleaning eggs, by female was detected more often just after they are laid and occasionally from time to time, till they hatch. One egg is picked up by the jaws and then is rotated with the help of both the labiums, so that the whole surface of egg comes in contact of the moving mandibles. With this process the whole surface of the egg is brushed. This process is repeated with each egg. Owing to this the eggs are always clean and no sand particles stick on to them.

PARASITES

During the course of the work a very large number of specimens of *Forcipula trispinosa* were examined and dissected, but no evidence was found of the presence of parasites. *F. auricularia*, however, is parasitized by a variety of organisms (Crumb, Eide and Bonn, 1941), Markham and Smith (1949) discovered a virus "turnip yellow mosaic virus", affecting cruciferous plants in Great Britain which is capable of transmission by *F. auricularia*.

METHOD

Different methods have been used by different authors to maintain continuous culture of different species of earwigs in the laboratory.

Behura (1956), while dealing with *F. auricularia* reared gravid females and nymphs in glass vials containing sterilized earth and cotton wool. A glass capillary was inserted through the cork stopper, so as to allow passage of air. Small pebbles were also placed inside for the earwigs to hide beneath in the day time.

Giles (1953), carried out all the breeding experiments with *Anisolabis littorea* in a double walled butter box heated by a fifteen watt electric lamp. Specimens were maintained in it in separate dishes which were partly shaded by black paper. Temperatures in this hot box taken in morning and afternoons over a period of some months showed a range of 66°F. to 73°F.

During the present study the author tried to maintain specimens of *Forcipula trispinosa* in jars containing sterilized earth. In this condition all the earwigs died within a short period of two or three days. In nature this species likes the moist earth under the stones at the banks of hill streams, lakes etc., which provides a condition most favourable to them.

Later the earwigs were reared in containers containing wet sterilized earth. Water was sprinkled at intervals as soon as the soil started drying.

After collecting gravid females and pairs of *F. trispinosa* they were brought to the laboratory and were reared in wide mouthed glass jars. The mouth of these jars was covered with a cloth piece. Sterilized moist earth was filled in these jars and small pieces of stones and pebbles were also placed inside for the earwigs to hide beneath in the day time.

After hatching each nymph was kept separately in glass tubes, containing wet soil. The adults and nymphs were fed daily on a diet of dead insects.

FOOD

The earwigs are omnivorous. Some are carnivorous while others feed purely on plant material.

The food requirement of *Forficula auricularia* has been a subject of much study in U.S.A. and Great Britain. Brindley (1920) gave a list of seventy-four species of plants including garden vegetables, flowers, fruits and weeds on which this omnivorous species feed. Various workers (Beall, 1932 ; Crumb, *et al.*, 1941 ; Guppy, 1946-47) have added a number of plants to this study. Crumb, *et al.*, (1941) and Fulton (1924) reviewed that it is one of the most omnivorous insect. It was noticed by many workers (Lustner, 1914 ; Dimick and Mote, 1934 ; Crumb, *et al.* 1941) that as to floral diet pollen is preferred to petals. Behura (1956) in carrying his breeding experiments reared nymphs and adults on a diet of dandelions, cabbage, potato peelings, dead flies, mosquitoes and spiders.

Burr (1910) states that "Green supposed that food of *Diplatys* consists of soft insect".

Burr (1910) records *Labidura riparia* feeding on blue-bottles. He also recorded many species in swarms on stinging nettles.

Burr (1910) quotes "Xambeu tells us that *Chelidura pyrenaica* is a variable glutton. Tender vegetables, fruits, worms and larvae are eaten..."

Notes on food and feeding habits of *Forcipula* are lacking. Therefore, an attempt was made by the author to describe the food and feeding habit of *Forcipula trispinosa*.

Forcipula trispinosa is certainly carnivorous. The author has never found it feeding on any plant matter. It is confirmed that its food consists of some of the animals found under stones. Of these mostly eaten are, spiders, cockroaches, flies, larvae etc. In laboratory they devour parts of their dead fellows. This necrophagus habit has been previously noted by many workers while dealing with *Forficula auricularia*

(Chapman, 1917 ; Jones, 1917 ; Brindley, 1918 ; Fulton 1924 and Behura, 1950).

During the present study, it was found that adults and nymphs of later stages, prey on younger nymphs. Giles (1953) records same behaviour, while working with *Anisolabis littorea*. This cannibalism must have some effect on population. In the nature young nymphs, disperse within four or five days of hatching and then lead a free life. In laboratory it was found that if nymphs are not reared separately after four or five days the mother preys her own nymphs. It was found that after some days all nymphs are eaten up by the female. Young nymphs are seized and devoured without the aid of the forceps. The female earwig catches them by a lightning movement with the help of mouth.

Laboratory specimens were maintained on a diet of dead house flies, cockroaches, spiders, small species of other earwigs and larvae of insects. To study the feeding behaviour, the author introduced a live cockroach into a jar with a female *Forcipula trispinosa*, which was starved for some days. The earwig seized the victim, between its forceps with a rapid movement. Then turned its abdomen round to one side so that the body of earwig, assumed U shape and the prey touched its mouth. The prey was then eaten, while still held by the forceps. When the earwig was disturbed, it moved away carrying the prey in the forceps. Dunlop (1865) (some Indian species), Terry (1905) and Risbec (1935) (both dealing with *Chelisoche morio*), state that the food is held in the forceps while it is devoured.

If live insects are regularly introduced inside a jar occupied by a female, *Forcipula trispinosa*, it either does not take any notice of the live prey or seizes it between its forceps. It waits till the prey dies and when the prey does not make any attempt to escape, the earwig either curls its body to one side so that the dead insect touches the mouth or drops the prey. The prey is then eaten. At times even the chitinous parts of the body of the prey are not left.

The other earwigs normally do not behave in this aggressive way when dead insects are given to them. They simply feed on dead insects.

If one earwig comes upon another while it is feeding, the rightful owner threatens the other by opening its forceps widely and directing it towards the other.

It has been observed that nymphs after second moult (third instar nymphs) become much aggressive. Once two nymphs were kept in a glass tube. A small piece of a dead cockroach was then placed inside the tube. One of the nymphs started to feed, but soon the other nymph tried to snatch the food. At first the former tried to threaten the later by opening

its forceps and then rapidly seized the prey between its forceps and ran away. Then it settled down in a quiet part of the tube, curled its abdomen and started to feed, while the food was still held by the forceps.

Giles (1953) starved specimens of *Anisolabis littorea* for four weeks without any adverse effects, suffering or any apparent harm. He records :

“It would appear that sporadic feeding is characteristic of the species in nature. The very large distensible crop is an important accessory to this.” Although the species, with which the author of the present work is dealing is different yet the observations lend support to the view of Giles. The author starved specimens of *Forcipula trispinosa*, for more than one month. The specimens caught in the field show a great attraction towards the food in the laboratory. Many times the whole prey, given to them is devoured and even chitinous body parts are not left.

Behura (1956) while dealing with *Forficula auricularia* recorded that nymphs and adults show a predilection for exuviae. But the author has not observed any nymph or adult of *Forcipula trispinosa* feeding on exuviae.

GYNANDROMORPHISM AND REGENERATION

As far back as 1910, Burr questioned the validity of true gynandromorphs. Burr (1939a) again questioned the observation. Qadri (1937) recorded the discovery of one gynandromorphous *Forficula auricularia*. Qadri's specimen was very interesting and possessed male genitalia, with one paramere slightly shorter and narrower than the other. Full compliment of male abdominal segments was present although pygidium was irregular.

One would expect a true asymmetrical gynandromorph to have externally, apart from the peculiar forceps, nine segments on one side of abdomen and seven on the other. Internally a sort of male and female reproductive organs would be expected. In this respect the form of genital armature of Qadri's specimen is very interesting.

Behura (1956) while working with *Forficula auricularia* records that traumatism of forceps in nymphal stage is responsible for the growth of male and female components of the asymmetrical forceps. When one branch of forceps of the male is lost in the first, second or early third nymphal stage, regeneration of missing part is almost complete. The loss of one branch of the male forceps after the third moult, however, produces a condition which allows the process of regeneration to produce only a simple female like branch evident after the fourth moult. If the loss occurs during the last quarter phase of third nymphal stage, the regenerated part is stunted.

During the present study the author has not recorded any male specimen in the field, having one branch of forceps like that of a female in *Forcipula trispinosa*.

The author agrees with the view of Behura (1956) that traumatism of forceps in nymphal stage is responsible for the growth of asymmetrical forceps. In *Forcipula trispinosa* it has been found that when a branch of male forceps is lost in the first, second, third, fourth or early fifth nymphal stage, regeneration of missing part is complete. Adult comes out of the old skin with the lost branch fully developed. If the loss occurs during half or last quarter phase of fifth nymphal stage the regenerated part is only partially reformed.

This observation, therefore, accounts for Callan's (1941) discovery of a specimen of *Forficula auricularia* having female forceps and male reproductive organs and for Morgan's (1926) discovery among 3000 earwigs examined by him, of seven specimens which had forceps with one jaw resembling that of female and the other that of adult male. Lhoste (1942a) proposed for this type of male, hitherto considered as a gynandromorph, the term "hiterocerque" (hiterocercus), and Behura (1956) shared the same view.

SEX RATIO

Study of sex ratio of *F. auricularia* was carried out by a number of authors in Europe and America in laboratory and field populations and their results differ considerably.

During the present study the author reared 112 nymphs of *Forcipula trispinosa* from egg to adult in the laboratory. Fifty-eight or 51.785% of them were males and fifty-four or 48.214% of them were females.

The result of the observations, pointed to slight female deficiency.

The result of the present work are based on a short term study. Therefore, one would not expect them to be definite, but rather an indication of sex ratio.

Table 1. : Number of males and females out of 112 nymphs of *Forcipula trispinosa*.

Serial No.	Number of males	Number of females
1	2	4
2	8	6
3	11	5
4	5	7
5	15	10
6	10	8
7	7	14
Total	58	54

The formula used for the standard error was S.E.

$$=0.6745 \sqrt{\frac{mf}{n}}$$

m=Percentage of males

f=Percentage of females

n=Total number counted.

The average percentage of males obtained by the author was 51.785±3.184

LIFE HISTORY

This study was carried out from early March which is the oviposition period. Field observations on egg laying provide support that egg laying does not commence until summers.

Room—temperature, over a period of some months showed a range of 60° to 85° F. Although some time, a fall in temperature took place due to cloudy weather and rains.

1. MATING

Several workers have observed mating of *Forficula*. De Geer (1773) was the first author, who observed and described mating of *Forficula*. Later several authors gave account of the mating of *Forficula*. Kerville (1907), Burr (1910), Fulton (1924 a), Goe (1925) and Kuhl (1928) described this phenomenon. Behura (1956) described mating of *Forficula auricularia* in some detail. Giles (1953) dealt with the copulation of *Anisolabis littorea*.

Account of the mating behaviour of *Forcipula* is lacking. Detailed observations were carried out during present study to describe the copulation of *Forcipula trispinosa*.

In nature mating reached a peak in March. With the departure of winters and onset of spring the specimens come out of their hiding places and are found in abundance. From early March the animal is found in pairs (usually one pair under one stone) at the bank of lakes and streams.

Pairs were collected and reared in the laboratory. Mating was observed in laboratory for the first time in March, 1976 (23. 3. 1976).

Copulation has been observed to take place at any time of the day. Prior to copulation the courtship takes place. It was observed that whenever the male approaches the female the latter raises the posterior end of its body. At intervals the male locates the female with the antennae

and at times they interlock their forceps. During this process male and female remain facing in opposite direction and the male is very active. The male opens its forceps wide enough to interlock its forceps with that of the female.

When the forceps are disengaged, after some time the posterior part of male's body is oriented in such a way that the ventral surface is parallel with that of the females ventral surface. The male intromittent organ is inserted between the tenth sternite and subgenital plate of female. In this position coitus, which lasts for a long time takes place. The pair remain motionless while in copula. After some time they move apart. The author found a pair in copula for more than one hour (1 hour and 7 minutes, 22. 3. 1976).

Repeated copulation is common. Pairs confined in jars were often found in copula on more than one occasion in one afternoon.

The male does not use the forceps at any time as claspers during the act. Forceps of each sex being extended along ventral surface of others body or male forceps were found extended along the lateral side of female's body, according to the posture attained at the time of copulation. Goe (1925) working with *Forficula auricularia* records that in copulation male uses the forceps as claspers round the female's abdomen. Behura (1956) reported that the male does not use the forceps as claspers at any time during the act in *Forficula auricularia*.

Although some variation in behaviour does occur, the above account describes the course generally followed.

Many times the author during the present study found that the male of *Forcipula trispinosa* tries to copulate with female while clinging to the under surface of the small stones or pebbles placed inside jar (for the earwigs to hide beneath in the day time) with the back pointing towards the bottom of the jar. In this condition many pairs in copula were seen in the laboratory. This position does not involve the torsion of the abdomen of the male. Burr (1910) quotes "Lesne observed a pair of *forficula lesnei* in coitu while hanging from the under surface of the cork of a tube."

2. OVIPOSITION

Forcipula trispinosa lays eggs normally during summer. It may be assumed that maximum temperature in this region is required to raise physiological activity of the female to induce oviposition. It has come to light that unusual high or low summer temperature could change the time of egg-laying. In 1976 first eggs were taken in the field on 18. 4. 76, which were just about to hatch. Most probably, they were laid seventeen

or eighteen days before collection. In laboratory a number of females kept at room temperature started to lay eggs on the following dates : 7th April, 11th, 17th, 18th and 29th April. From these observations it is clear that egg-laying normally starts in this region from early April.

In 1977 eggs were laid in the laboratory on 10th, 11th, 14th, 22nd and 24th April. In the field eggs were collected on the following dates : 6th, 12th and 13th April.

In the field the eggs are laid in damp depressions under stones near the bank or hill streams, lakes etc. These are the areas which remain submerged in water during rains and winter. In summer, evaporation of water from these areas make them suitable for egg laying. Floor of depression is cleared of rubbish and is smooth (although in laboratory due to absence of smooth surface females also laid their eggs in rough sandy surface).

In the laboratory it was found that females start making nest some days before oviposition. At first she makes depression under the stone. Then the female comes out of the depression and starts depositing sand particles around that particular stone, so that only a small hole is left for entrance. Female crawls through the said hole and there she lays eggs. Some time the only hole is closed from inside with the sand particles. The female broods over eggs until they hatch.

Eggs are laid over a period of two or three days. Burr (1910) quotes "In Ceylon, Green observed *Diplatys greeni* depositing its eggs at intervals, during a week, until a total of twenty-five had been laid." Behura (1950) records *Forficula auricularia*, laying its eggs over a limited period of two or rarely three days.

It was difficult to record the time that elapsed between copulation and oviposition. Male and female which were caught in the field and were kept in pairs, in laboratory, were found in copula many times, till the female finally laid the eggs.

Female was found restless even after the eggs are laid. She moves the pile of eggs from day to day. If the eggs are disturbed the female again deposits them in a mass by gripping them one by one in her mouth.

As soon as the eggs hatch, the female removes sand particles from a small area so that an exit (in the form of a small hole through which only the female can pass) is created. Often the female is found protruding her antennae and head through the exit. Occasionally it crawls outside the nest, and carries dead insects for its young ones inside the nest, siezed by the jaws.

In laboratory all females laid their eggs of the second batch

approximately a month after the first batch of eggs had been laid. But it was found that in exceptionally cold summer due to rains this period is changed.

In laboratory some of the females laid a third batch of eggs. It was discovered that females showed a predilection for eating the eggs of their third brood. Two females which laid their eggs on 30.6.76 and 1.7.76. ate them. It was observed that generally the females lay their eggs of third brood in late June or early July, when rainy season starts in this region, and conditions become unfavourable for their development. It was observed that if eggs of the first brood were destroyed, the period between the laying of eggs of the first and second brood was shortened. In the laboratory a female laid her eggs on 7th April, 1976 which were destroyed by the author. The female laid second batch of eggs after a short period of 20 days i.e., on the 27th April, 1976 and then laid its third batch on the 24th May 76. This was the only instance where the female showed the same normal parental care for the eggs of the third brood and the young ones came out after some days.

It was observed that eggs of all batches are fertilized before first oviposition. One mating period was found sufficient for a female which deposited three batches of eggs.

In laboratory, three females laid the second batch of second brood eggs, not under stones but simply on the surface of moist sand while some others again laid the eggs of second brood under stones, in the nest especially made by the female. In the field the eggs of second brood were found under stones in damp depressions as the eggs of first brood. It is, apparent that if the females lay their eggs in the field simply on the surface of the earth, they will come in direct contact with sun-rays, which will cause damage to the eggs and developing embryos. Moreover, the eggs may be eaten by the other predatory insects.

In the laboratory the absence of competitors in isolated jars, and the presence of enough moisture induced the females to lay their eggs of the second brood in the open.

The first brood, as is already described was laid in both laboratory and field by all females inside the nest covered from outside by sand particles. This is done to maintain the temperature inside the nest, so that the developing eggs may not be influenced by the fluctuations of temperature in March. Therefore, laying of eggs in damp depressions under stone solves the following purposes.

- I. Eggs are protected from enemies and predatory insects.
- II. Eggs and developing embryos are protected from direct sunlight and the moisture necessary for development is maintained.

III. Eggs and developing embryos are protected from the fluctuations in temperature.

The results show that *Forcipula trispinosa* is a species of earwigs which lays more eggs in comparison to any other species of earwigs recorded so far. Average number of eggs laid, for the first brood, in the laboratory was 71.14 while average number of eggs laid by females in the field for the first brood gave a result of 55.83. The total number of eggs for the first and second brood and in one case the third brood are presented in table-4. The figures were ranging from 120-152 and in one case it was 238.

It was recorded that the number of eggs in the first brood varies from 50 to 81 with an average of 71.14 while that of the second brood is higher varying from 70 to 103 with an average of 90.

Table 2. Number of first-brood eggs laid by females of *Forcipula trispinosa* in the laboratory.

Serial No.	Date on which found	Number
1.	7.4.76	81
2.	10.4.76	77
3.	29.4.76	50
4.	11.4.77	67
5.	14.4.77	65
6.	22.4.77	78
7.	24.4.77	80
Average		71.14

Table 3. Number of first-brood eggs laid by females of *Forcipula trispinosa* in the field.

Serial No.	Date on which found	Number of eggs
1.	18.4.76	63
2.	18.4.76	55
3.	19.4.76	60
4.	6.4.77	65
5.	12.4.77	40
6.	13.4.77	52
Average		55.83

3. INCUBATION

Eggs are creamy white ovoid in shape when laid and shining like tiny pearls. They are always clean and quite smooth. Measurements taken of fifty recently laid eggs selected at random from field material and the laboratory gave following results :—

Length : about 1 mm.
Breadth : about .5 mm.

Table 4. Number of eggs laid by individual females of *F. trispinosa* during oviposition periods

Serial No.	Date of collection from field	With or without eggs	First oviposition		Second oviposition		Third oviposition		total
			Date	No. of eggs	Date	No. of eggs	Date	No. of eggs	
1.	21.3.76	A couple	7.4.76	81	27.4.76	90	24.5.76	67	238
2.	21.3.76	A couple	29.4.76	50	5.6.76	70	...	...	120
3.	18.4.76	With eggs	...	63	2.5.76	89	30.6.76	Ate her eggs	152
4.	18.4.76	With eggs	...	55					
5.	24.4.76	Solitary	...	...	9.5.76	103	1.7.76	Ate her eggs	
6.	3.5.76	With young ones	...	...	22.5.76	98			
7.	30.3.77	A couple	22.4.77	78					
8.	3.4.77	A couple	11.4.77	67					
Average				65.66	90				

As the eggs develop they increase in size, become whiter and translucent. Later the structure of the embryo becomes visible through the shell. The Head at one end is found touching the posterior curved end of the body. The body segments are also easily seen. The eyes are clearly visible as a pair of black spots. At this stage the eggs are about twice the size of the newly laid ones. They are very turgid and kidney shaped and of bouncing nature when dropped on a smooth hard surface.

The measurement of eggs about to hatch gave the following result :

Length :	1.5. to 1.8 mm.
Breadth :	1 to 1.2 mm.

Behura (1956) records "In a publication of British Museum (Guide to the Exhibited Series of Insects, 1926, pp. 17-18, Fig. 15) there appears a diagram of the egg of *F. auricularia* with the developing embryo inside, especially showing the jointed character of cerci, with the statement that "the jointed character of the cerci can, however, be seen while the insect is still in the egg," In my investigation I discovered that the cerci are unjointed when the insect is still in the egg and dissection of eggs about to hatch confirmed the same findings." The author of the present work also carried the same type of experiment with the eggs of *Forcipula trispinosa* about to hatch. It was found that cerci of developing embryo are unjointed when the insect is still in the egg.

The duration of incubation period of different batches of eggs at the laboratory temperature is presented in Table 5.

It was found that a rise in temperature reduces the incubation period while a fall in temperature due to rains increased the incubation period.

In 1977 the room temperature was very low during the whole summer due to cloudy weather and rains. The exceptional cold summer influenced the incubation period and the youngs emerged approximately after one month of egg laying of the first brood eggs.

4. PARENTAL CARE

Parental care is a very remarkable feature in the life of earwigs and is found in a wide range of species of earwigs. Parental care was first reported by De Geer in 1773. De Kerville (1907) recorded much information on the subject available up to that year. A number of authors have recorded parental care in *Forficula auricularia*. Sharp (1901), Jones (1917), Lucas (1920), Goe (1925), Carpenter (1928), Crumb, Eide and Bonn (1941), Imms (1948), and Behura (1956) dealt with parental care in *Forficula auricularia*. The parental care is reported by Terry (1905) in *Euborellia annulipes* and *Chelisochea morio*, by Lucas (1920) in *Labidura riparia*, by

Table 5. Duration of incubation period of different batches of eggs of *F. trispinosa* at laboratory temperature

Serial No.	First Brood			Second Brood			Third Brood		
	Date of egg laying	Date of hatching	Duration in days	Date of egg laying	Date of hatching	Duration in days	Date of egg laying	Date of hatching	Duration in days
1.	11.4.76	29.4.76	18						
2.	17.4.76	5.5.76	18	18.5.76	30.5.76	12			
3.	18.4.76	5.5.76	17	21.5.76	3.6.76	13			
4.	7.4.76	...	...	27.4.76	11.5.76	14	24.5.76	3.6.76	10
5.	29.4.76	14.5.76	15						
6.				2.5.76	17.5.76	15	30.6.76	Ate her eggs	
7.				9.5.76	24.5.76	15		-do-	
8.				27.5.76	6.6.76	10			

Hincks (1948) in *Prolabia arachidis*. Main (1927) states that the female of *A. maritima* does "not brood over her ova" but occasionally moves them and "carries the young nymphs between her mandibles into the burrow which she had made." But on other hand Guppy (1950) reported that "as in usual with Dermaptera, female *Anisolabis* watch over and care for their eggs and young nymphs."

The author of the present work collected a number of interesting notes on parental care of earwig *F. trispinosa*, during this study in the Nainital region, on biology.

Many times the author found the female of *F. trispinosa* under stones, in depressions, together with a pile of eggs on which or near which it was seated.

At the commencement of the month of April in 1976, the author found a female of *Forcipula trispinosa* under a stone with a number of eggs which were not less than 40. On lifting the stone the eggs were disturbed and scattered nearby. The female remained stationary for some time and then she took the eggs one after the other between her jaws and deposited them together. During this act she also removed a small stone particle which was covering some eggs. This type of behaviour of collecting disturbed eggs was observed many times in the laboratory. On the other hand Giles (1953) points out a different behaviour in *Anisolabis littorea*. His remarks are worth quoting "On being disturbed, she will either adopt the characteristic defensive attitude of the species or carry the eggs singly between the tips of the mandibles and maxillae, scattering them over the floor of the depression. This is doubtless done for protective purposes."

Another time on a lifting a stone a female was found accompanied by several small youngones and some eggs about to hatch. The nymphs scuttle rapidly to the places of safety and cluster together for mutual protection, while some were still grouped round the mother and did not leave her. The stone was now placed by the author in its original position. After a careful observation later it was found that the young ones were again clustered around the mother.

Young nymphs depend upon the female for protection for some days. They remain grouped with the mother. (same type of clustering together was observed when eggs, about to hatch were collected from the field and nymphs raised from them, were kept in the laboratory in the absence of the female).

In the laboratory it was found that after hatching the female occasionally comes out of the nest and carries dead insects seized between her mandible for the young ones. This gregariousness and dependence

on the female is lost as the life cycle advances. After some days the young ones crawl out of the depression and disperse. This scattering is very necessary for the preservation of the species. Now they lead an independent life.

Some times a tendency of concealing eggs by the female at the sight of danger or threat was found in the laboratory.

Once a batch of eggs was found in the laboratory brooded by female under a stone placed inside the jar. The author counted the eggs and placed them in their original position. This study of the behaviour and parental care disturbed the female many times. Next day on lifting the stone, the author did not find even a single egg. About half of the eggs were discovered by the author buried under sand particles. It appears that the mother concealed the eggs. Burr (1910) states that Xamheu describes habit of concealing of the eggs in *Chelidura pyrenaica*.

It was found that whenever a decrease in humidity takes place in the jar, in the laboratory, the female *Forcipula trispinosa*, spreads the eggs in a way that each egg comes in direct contact with the damp soil. When water was sprinkled on the surface of the sand, the female again heaped them in a mass.

Giles (1953) working with *Anisolabis littorea* observed that when a female with very young nymphs is disturbed it deposits the nymphs a little distance away from the main group by gripping them singly in her mouth parts. But the author of the present study did not find this behaviour pattern while working with *Forcipula trispinosa*.

5. HATCHING

In *Forficula auricularia*, hatching had been studied by Fulton (1924) in America. Later his interesting discoveries were confirmed by Behura (1956). Giles (1953) observed hatching of *Anisolabis littorea*.

During the present study eclosion in *Forcipula trispinosa* was studied by the author in the laboratory for the first time on 19.4.76.

As soon as the egg membrane bursts in the region of the head, it takes a few minutes for the nymph to free its legs, antennae and cerci, and it crawls through the egg case within a short period (2 to 4 minutes). Remains of the egg are eaten by other freshly hatched nymphs. The nymph is pure white in colour and transparent. Crawling at first is uncertain but soon the mechanism becomes more smooth and the animal is able to move easily. At this stage the nymph is very soft and delicate. Forceps are of very unusual shape but soon it becomes hard and straight. After some time the nymph settles down in a quite corner of the jar to

develop pigmentation. It resembles the adult earwig but has no trace of wings.

The pigment does not take any definite course in spreading, but the examination of a few freshly hatched nymphs gave the following result : At first the head appears pigmented faint grey, and after some time assumes dark grey colour. Next the area of pronotum becomes pigmented. The posterior end of abdomen, thorax, antennae and caudal appendages are found pigmented. Legs are tawny and the whole body assumes the usual grey colour. It takes about two to two and half hours for freshly hatched nymph to attain a moderate degree of greyishness over the whole of the body and about five to five and a half hours to assume the usual dark grey colour. The freshly hatched nymph is larger than the nymph which acquires the normal grey colour.

During the development of earwig from hatching to maturity it sheds its skin five times. In a nymph about to moult, body becomes distended and wide bands of inter-segmental membrane are visible between the sclerites. At the initiation of the moult antennae are stretched along the ventral surface of the abdomen, and labium touches the neck and prosternum. Splitting takes place along medial dorsal line and anterior portion of exuviae opens. Finally the nymph crawls out of the old skin.

It was observed by the author that in the nymph about to moult there is a great variation in colour between head and abdomen. The head is of usual dark brown blackish colour but the abdomen becomes light brown some days before moulting. This difference between the colour of the head and abdomen increases as soon as the time of moulting comes nearer.

After each moult the nymph is pure white, transparent and has a inflated appearance. Again after some time the whole body assumes the usual brown blackish colour.

Giles (1953) dealing with *Anisolabis littorea* observed that exuviae is generally not eaten and may be recovered. The author of the present study did not find a single exuviae eaten by the nymphs of *Forcipula trispinosa*, after moulting.

6. NUMBER OF INSTARS

A wide range of dermaptera have four nymphal instars. Jones (1917), Fulton (1924), Crumb, Eide and Bonn (1941), Lhoste (1942), Henson (1946-1947), Hincks (1949a) and Behura (1950) state that *F. auricularia* has four nymphal instars. Chapman (1917) mentioned six ecdyses in *Forficula auricularia*. Lucas (1920) and Imms (1948) quoted

Chapman's observation of six ecdyses. Chapman (1917a) corrected his observations in a subsequent paper discovered four moults only. Four nymphal instars were recorded by Lhoste (1942) for *Chelidurella acanthopygia*; Terry (1905, 1906) and Hincks (1948, 1949a) for *Chelisoches morio*; Hincks (1948, 1949a) for *Euborellia annulipes*, *Labia curvicauda* and *Prolabia arachidis*. Five nymphal instars were recorded in *Anisolabis littorea* by Giles (1953).

During the present study five nymphal instars were recorded by the author in *Forcipula trispinosa*. The stages in the life cycle can be distinguished by the changes in features of thorax, the number of antennal segments and the shape and size of the forceps.

The antennae in the first instar consist of 8 segments; in the second instar 18 segments; in the third instar 24 segments; in the fourth instar 29 segments; in the fifth instar 34 segments and in the adult 35 segments. During the first moult, the third segment divides into 11 segments, producing thereby the 18 segments of second instars. In second moult, the third segment is again divided into 7 segments, thus giving rise to 24 segments of the third instar. In each of the third and fourth moult, the third segment is divided further into 6 segments thereby resulting in 29 and 34 segments, respectively of fourth and fifth instar. In fifth and final moult, the third segment is divided into 2 segments thereby resulting in the 35 segments of the adult.

Due to fragile and delicate nature of antennae, the full compliment of 35 segments of adult antennae is rarely retained. Of a large number of earwigs bred in the laboratory only 15 adults retained the full compliment of 35 segments of both antennae.

In the thorax of first instar, segments are transverse and of more or less uniform width throughout. In the succeeding instars pronotum becomes more quadrate. The posterior angles of the metanotum become lobed in second, third and fourth instars and develop wing pads in fifth instar. The pygidium, is seen as a tubercle in the first, second, third and fourth instars. But it becomes fused with the last dorsal segment which is deflexed between the forceps and thus presents a vertical face in the fifth instar and gives typical family character.

The forceps in the first instar are straight, delicate, filiform appendages. In succeeding instars the increase in length and relative thickness takes place. Sexual dimorphism is not exhibited by nymphal stages, all possess the female type forceps and there is no differentiation between male and female forceps. After 5th moult the male comes out of the old skin with typical male type forceps.

7. DURATION OF INSTARS

Much attention has been given to the duration of various stages of *Foficula auricularia*. Crumb, *et al.* (1941) in America has given the duration of the various stages. Henson (1946) states that the period for the first instars was about 24 days. Behura (1950 and 1956) studied the life cycle and biology of *Forficula auricularia* in detail. Giles (1953) described the duration of stages of *Anisolabis littorea*, while dealing with the biology.

In India no serious work has been done to describe the biology of earwigs. During the present study the author carried out experiments to record the duration of the various stages of *Forcipula trispinosa*. A number of earwigs were reared from egg to the adult stages at room temperature. Immediately after eclosion each young nymph was transferred to a glass vial.

The duration of stages is given in table 6 and 7.

Table 6. The duration of stadia of the first brood at room temperature in the life cycle of *F. trispinosa* starting from first instar nymphs which emerged from eggs in the third week of April, 1976.

Nymphal instar	Range of duration in days	Average period in days
First	10 to 12	10.885
Second	6 to 8	7.033
Third	8 to 14	11.481
Fourth	10 to 13	11.50
Fifth	14 to 25	18.428
From hatching to maturity		
Male	56 to 68	61.375
Female	53 to 60	55.668

Table 7. The duration of stadia of the first brood at room temperature in the life cycle of *F. trispinosa* starting from first instar nymphs which emerged from eggs on 5.5.76

Nymphal instar	Range of duration in days	Average period in days
First	6 to 9	7.317
Second	10 to 12	11.256
Third	7 to 10	8.225
Fourth	12 to 19	13.722
Fifth	19 to 32	23
From hatching to maturity		
Male	60 to 73	66.272
Female	59 to 70	63

It was found that the temperature affects the duration of various stages. With the rise of temperature the duration of stadia is reduced, while a fall in temperature due to climatic conditions, increases the duration.

It was difficult to record the duration of stadia of nymphs emerged from second brood eggs. The nymphs of second brood eggs appear from mid May to early June. The duration of first, second or in some cases the third instar is less than those of the nymphs emerged from first brood eggs. But as soon as they reach their last nymphal stages the temperature falls in this region due to the onset of the rainy season. Thus the duration of various stages and broods is variable, depending on the climatic conditions.

8. GROWTH RATE

Measurements of different instars of *Forcipula trispinosa* are given in Table 8.

9. SEASONAL HISTORY

During the present study frequent visits to the field and breeding places were carried out to study various aspects of the subject, in *Forcipula trispinosa*.

In field the pairing starts from mid March and pairs are found till the end of the March, generally one pair under one stone, at the bank of hill streams, lakes etc.

It was found that after laying eggs the female drives the male from the nest. In laboratory, the author did not find any male, killed by the brooding female. But Behura (1956) working with *Forficula auricularia* recorded males killed by brooding females.

Oviposition in this region starts in early April and reaches a peak in the middle of April. Some females were found laying eggs till the end of this month. Due to this variation in oviposition, variation in incubation period and nymphal development, nymphs of different stages are found in the field.

In field it was found that first instar nymphs appeared on the soil from middle of April to early May. Some first instar nymphs were found till middle of May. Most of the first instars changed to second instars in the middle of May. The second instar changed to third late in May. The third changed to fourth in early June. Fourth instars changed to fifth in middle of June. The adults appeared late in June to July. A few

Table 8. : Measurement (in millimeters) of instars of *Forcipula trispinosa* (Alcoholic specimen)

Instars		1	2	3	4	5	6	7	8	9	10	Average
First	Body	4	4	4.8	4.5	3.8	4.5	4.2	4	3.9	4.7	4.24
	Antennae	3.7	3.6	3.5	3.5	3.1	4	3.7	3.8	3.6	3.9	3.65
	Forceps	2	2.2	2	2.1	2	2.1	2.1	2	2	2.1	2.06
Second	Body	7	7	7	6	6	6	5	5.5	5	6	6.05
	Antennae	5.7	5	5.8	—	5	6	5	6	5.8	5.2	5.50
	Forceps	2.5	3	2.8	3	2.5	2.8	2.5	2.8	3	2.8	2.77
Third	Body	8	8	9	9	9.1	8.5	9	9	8.5	9	8.71
	Antennae	8.3	8.1	8.4	8	8.5	8	8.5	8	8.5	8	8.23
	Forceps	4	3.5	3.5	3.4	3.9	3	3.5	3.5	3.5	3	3.48
Fourth	Body	12	12	13	11	14	11	12	12	11	12.5	12.05
	Antennae	11.2	—	10	10	10.5	11	12	11.5	11.6	11	10.97
	Forceps	4	4.5	4	4.6	4.5	5	4.8	4.5	4	4.3	4.42
Fifth	Body	17	15.5	15.8	15	16	14	17	17	15	14	15.63
	Antennae	11.5	14	—	14.5	14.5	13	14	14	—	14	13.62
	Forceps	5.5	6.5	7	6	6	6.5	5	5	5.5	5.5	5.85
Adult	Body	19	20	19	18	18	18.5	19.5	19	19.5	19.5	19.05
Male	Antennae	15	15.5	15.3	15	14	15	14.5	15.8	15.8	15	15.11
	Forceps	9	8	9	8.2	8	8	8.2	8.5	8.5	9	8.54
Female	Body	20	21	19	20	20.5	21.5	21	21.2	21.2	20.5	20.57
	Forceps	6	6.5	5.5	5	6.1	6.2	5.5	6.4	6.4	6	5.92

adults were found in the middle of June. These were probably the individuals which came into existence from a few batches of eggs, laid by a few females, in early April.

From early May to end of May, eggs of second batch were found in the field. In the laboratory also many of the females laid their eggs during this month. It was found from the observations in laboratory that second batch of eggs are laid approximately a month after the first batch of eggs have been laid. Youngs appear above the ground from middle of May to early June.

In laboratory some of the females laid a third batch of eggs. So this is a direct evidence that some females in the field may lay a third brood of eggs. In laboratory it was observed that the female shows a predilection for eating the eggs of their third brood which were laid in early July when rains start in this region and the temperature drops down making conditions unfavourable in the field for the developing eggs. Eggs were laid scattered upon the surface of the soil (in laboratory) and often each one was eaten as soon as it was laid.

Adults of new generation entered the soil between mid December to early January. Maximum entry depends on the advent of cold weather.

It was observed in both the laboratory and the field that females do not lay eggs in autumn.

Adults of new generation again appear on the surface of the soil, with the onset of the summer. They make pairs in March and then lay eggs in April.

From all evidence it is clear that *Forcipula trispinosa* has a potential life cycle of more than one year. It would seem that nymphs hatched in summer become adult within few months. They enter the soil in winters. Female oviposit at the end of their first year in March. Attempts were made to study the age of this species. The author reared males and females in laboratory in 1976 which were hatched in summer and had matured by June-July. In winter, despite all precautions, all of them died except one female. This female died in August, 1977. The above observation gives support to the view that *Forcipula trispinosa* has an age of more than one year.

Observations in laboratory support the influence of climatic conditions in seasonal history. The usual incubation period of first brood eggs was 15 to 18 days in April and May, and of second brood 10-15 days in May and June. But in 1977 the room temperature was very low throughout the summer due to rains. The exceptional cold summer influenced the incubation period and youngs emerged approximately after one month

of egg laying. This year, there was only one batch of eggs and the female did not lay a second batch. The air temperature and a long incubation period of the first brood eggs influenced further oviposition. It was also observed that with the falling of the temperature the duration of instars increases. Therefore, oviposition, incubation and post embryonic development vary from year to year in the same region in the field and the climatic conditions are responsible for these variations.

SUMMARY

(1) Nymphs and adults of *Forcipula trispinosa* were reared in glass-tubes and jars respectively. The tubes and jars contained a layer of moist sterilized earth. The earwigs thrived on a diet of dead insects.

(2) It was definitely established for the first time that there are two and occasionally three broods in a year in the Nainital region.

(3) The males usually survive until March, the mating period, and in winters they enter the soil. Maximum entry depends on the advent of cold weather.

(4) Traumatism of forceps in the last half or quarter phase of the final (fifth) nymphal instar is responsible for the condition known as gynandromorphism but the word "heterocercus" is regarded as a better term in this connection.

(5) The forceps are used mainly for defence and capturing food.

(6) A statistical examination of the proportion of males and females in laboratory cultures showed that there was slight female deficiency in *F. trispinosa*.

(7) Mating takes place in March when pairs are found under stones. Juxtaposition is effected by the apposition of the ventral surfaces of the sexes while facing opposite directions.

(8) The number of eggs in the first brood varies from 50 to 81 with an average of 71.14, while that of second brood is higher varying from 70 to 103 with an average of 90.

(9) At the laboratory temperature the incubation period of the first brood eggs lasts from 15 to 18 days, that of the second brood from 10 to 15 days and for a third brood incubation lasts 10 days.

(10) The larva after each moult is pure white ; It takes about 5 hours to attain the usual grey colour. Pigmentation of the cuticle does not follow a definite pattern.

(11) There are five moults in the life cycle of *F. trispinosa*.

(12) The average duration of the stages at the laboratory temperatures of nymphs emerging from first brood eggs in the third week of April, 1976, was I-11, II-7, III-11, IV-11 and V-18 days with 58 days average period for the completion of the life cycle from hatching to maturity.

(13) Temperature is a limiting factor.

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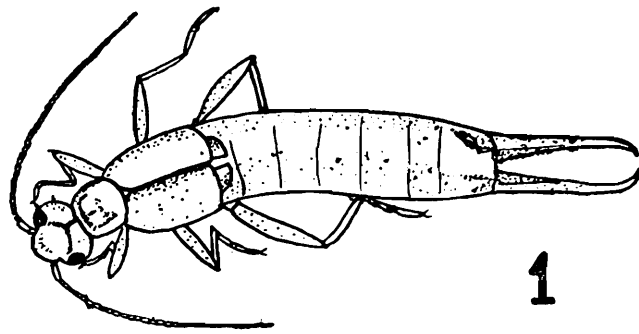
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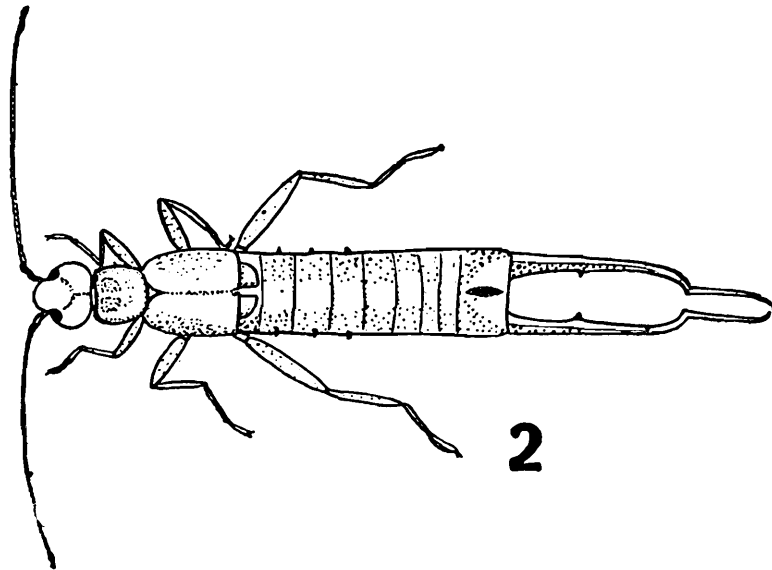
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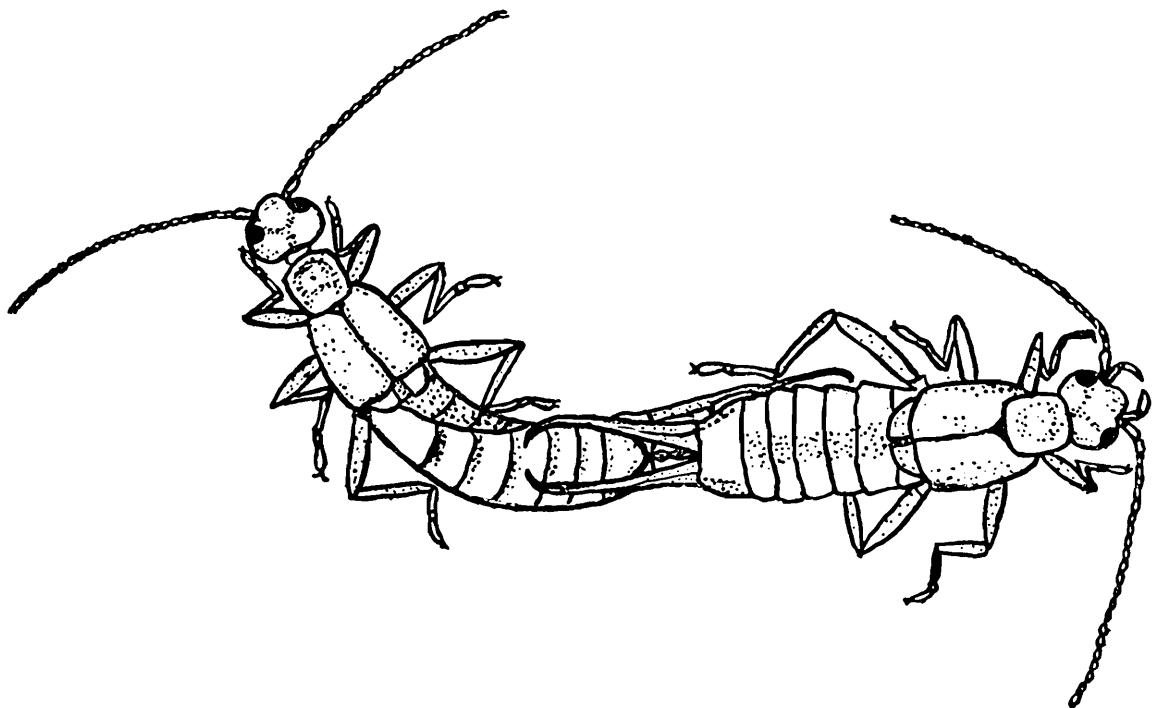


10mm.



10 mm.

Fig. 1. *Forcipula trispinosa* (Dohrn). ♀ Fig. 2. Id. Male.



10mm

Fig. 3. *F. trispinosa* (Dohrn). A pair in copula.

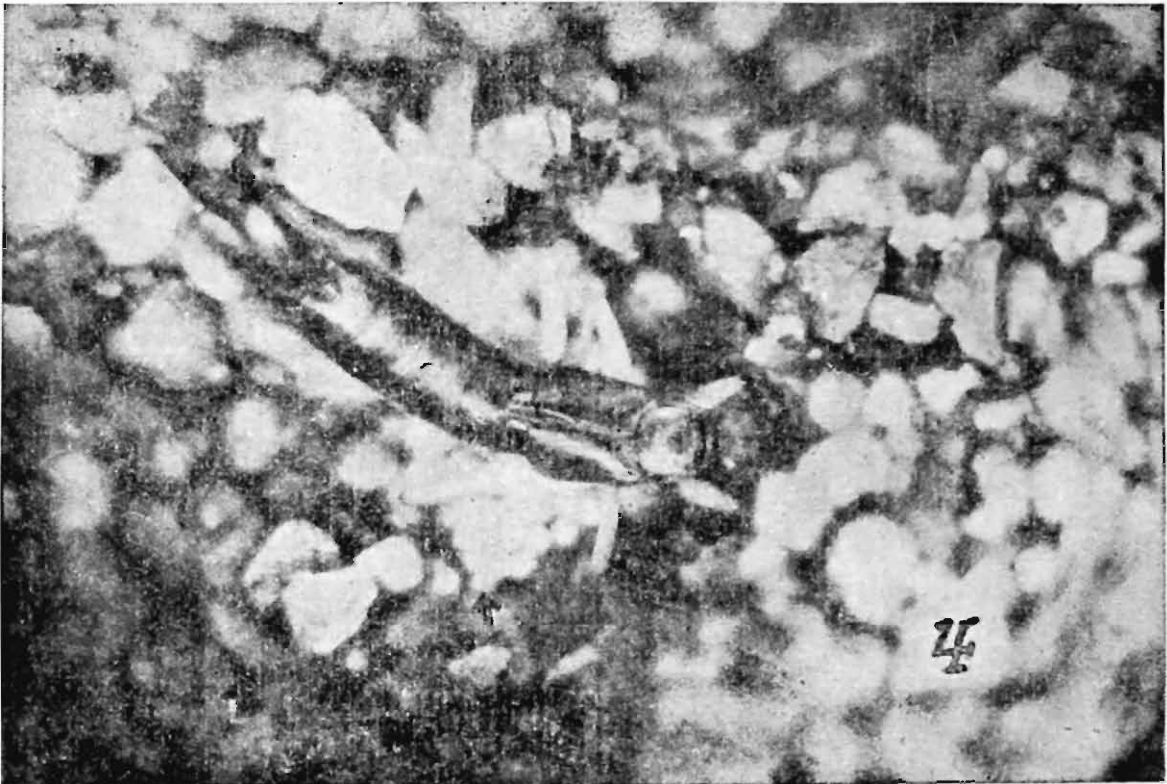


Fig. 4. Female with eggs (Parental care).



Fig. 5. Female with eggs.

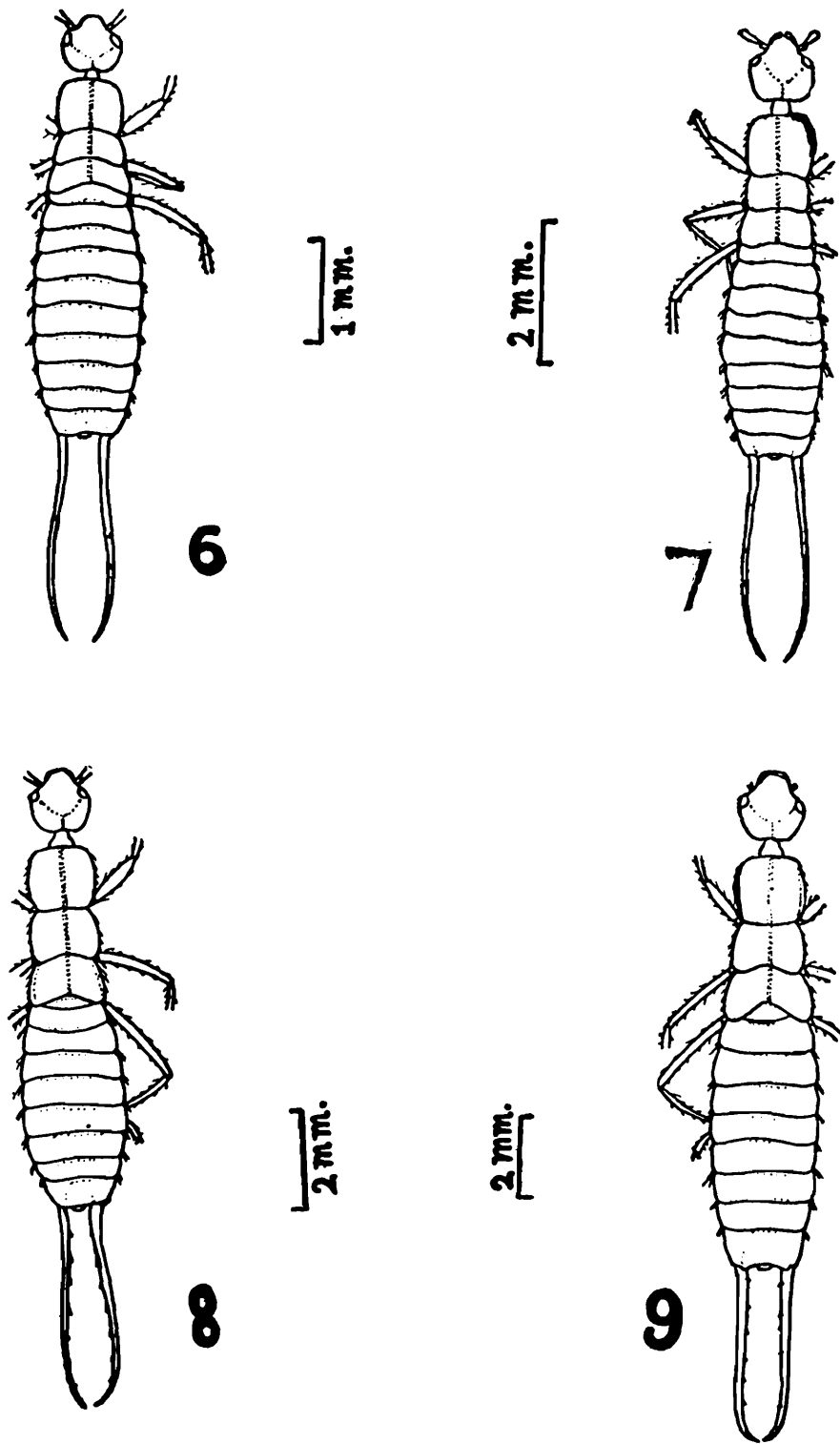
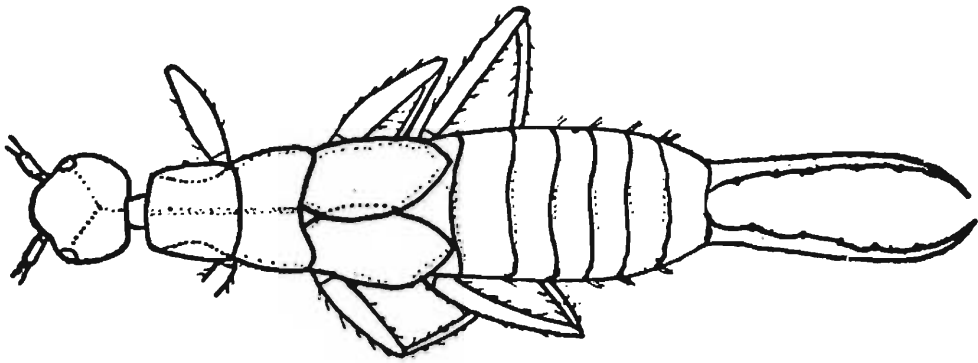


Fig. 6. *F. trispinosa* (Dohrn). First instar nymph.

Fig. 7. Id. second instar nymph.

Fig. 8. Id. Third instar nymph.

Fig. 9. Id. Fourth instar nymph.



10



4mm.

Fig. 10. *F. trispinosa* (Dohrn). Fifth instar nymph.

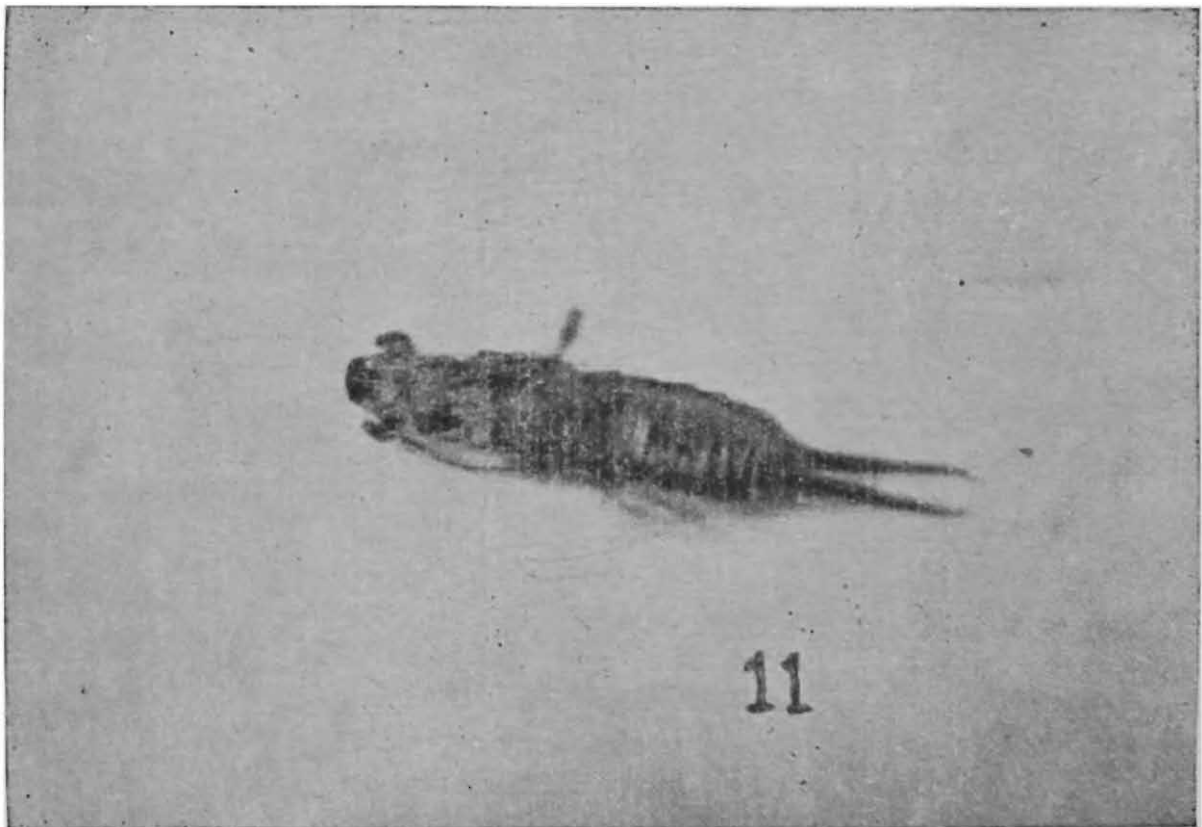


Fig. 11. *F. trispinosa* (Dohrn) Exuviae left after fifth moult.