The Grasshopper *Tachycines asynamorus*,
a new laboratory animal for cytological purposes

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Some years ago the senior author, Mohr, was informed by the state entomologist, Mr. T. H. Schöyen, that an alien locustid, *Diestrammena marmorata* De Haan, had been encountered in a considerable number in a greenhouse near Oslo, Norway. Through the kind assistance of Mr. Schöyen a number of living specimens were secured, and because of the well known advantages of the locustid material from a cytological point of view, it was decided to try whether this grasshopper might be bred in the laboratory.

This proved very simple indeed. And since the animal provides excellent material both for special purposes and for students work in cytology, a brief account of our experiences may perhaps be of use to other workers.

Taxonomical remarks, occurrence and description

According to later information from Mr. Schöyen the correct name of the species is *Tachycines asynamorus* Aden, this form having for a long time in the literature been confused with the very similar looking *Diestrammena marmorata* De Haan. The species, which is a Japanese orthopteran, was under older orthopteran taxonomy included in the family Locustidae. But according to Makino (1931) who recently studied the chromosomes of *Diestrammena japonica* Karny, belonging to the same genus, these wingless grasshoppers are now included in the family Stenopelmatidae.

Probably originally introduced with plants directly from Japan, *Tachycines* has now become wide-spread in Europe. At present, it is becoming quite a nuisance in different greenhouses around Oslo. Boas (1901) who at the beginning of this century gave an account of its
appearance in greenhouses in different parts of Denmark, mentions informations to the effect that the animal has also been encountered in English greenhouses. And SCHELLENBERG, who in 1913 published a paper dealing with the spermatogenesis of the species, obtained his material from German greenhouses. Though we have no information on this point, there is in view of the above every reason to assume that this grasshopper now must have been introduced to The United States also.

Both in nymph stages and as adult Tachycines asynamorus is completely wingless. The adult female (see Fig. 1) is about 2 cm. in length, the male slightly smaller. The end of the abdomen is in the female provided with a big ovipositor, in adult specimens more than 1 cm. in length. The length of the antennae may reach 6 cm. in both sexes, but their ends are not infrequently broken off. The very large and strong hind legs make the animal an excellent jumper.

The body color is in both sexes and at all stages a light brownish-gray ground color, rather irregularly covered with dark brown patches. Along the abdominal tergites the dark areas condense into more or less distinct transversal bands. In the lower part of the femur as well as on the tibia they form characteristic rings. The distinction between males and females is very easy, thanks to the female ovipositor which is plainly seen even in young stages.

The obovate, white eggs which are deposited in, or occasionally on the surface of the ground, measure 2.0 × 0.7 mm. One side is more convex than the opposite. The new hatched nymphs are 2.5 mm. in length and pale in color, but a pigmentation like that of the adult develops very soon.
Tachycines asynamorus is an animal of nocturnal habits. During the day-time it keeps hidden in holes, under stones, etc., not getting active until darkness sets in. Even in greenhouses where these grasshoppers occur in large numbers, it is therefore rather difficult to find them during the day, and the stock animals should be caught in the evening or at night.

As regards feeding habits Tachycines is a very ferocious animal. In the greenhouses it does considerable damage to different flowering plants as for instance Cyclamen, Adiantum and Chrysanthemum, and with excellent appetite it feeds on the most different fresh vegetables, such as salad, cabbage or germinating seeds of grain. The animal is also carnivorous. In too crowded laboratory cultures it kills and devours nymphs of its own tribe, and, according to Boas, it may even dispose of the lard or meat in rat-traps placed in the greenhouses.

By etherization, as applied in ordinary Drosophila work, this grasshopper is very convenient to handle. It is quickly narcotized, and even young nymphs sustain the narcosis for a considerable time without harm.

Breeding Tachycines in the laboratory

Technical remarks

The first stock animals obtained were placed in ordinary flower-pots filled with garden earth into which a 10-15 cm. high, cylindrical, bottom-less cage of brass wire gauze was gently pressed. The cage of a diameter slightly smaller than the opening of the flower-pot, was provided with a door for deposition of food, removal of animals, etc.

For food was used a small head of salad that was renewed every five or six days. By appropriate watering the earth was prevented from getting too dry. These flower-pot cages were kept in constant darkness in a cupboard. By aid of an electric bulb with the ordinary incubator arrangement the temperature in the cupboard is kept at 23°C.

By this simple and inexpensive method the animals do very well and propagate readily both in mass and in pair cultures. A full account of the breeding habits will be given later. The following information on particular points of special interest to cytologists is derived from matings which had as their main purpose to secure sufficient material of young nymphs for an X-ray investigation in which the junior author is presently engaged.
Of foremost importance is the fact that the egg laying and hatching periods are not restricted to a particular part of the year. Adult specimens may be obtained in the greenhouses at any time, and in our laboratory new hatched nymphs have appeared during all of the following months: January, February, March, April, May, July and September. For the remaining months special records are lacking, but judging from the varying size of the nymphs in old mass cultures it can hardly be doubted that individuals have emerged during these months also.

Both the egg laying and the hatching periods last for months. By making up a few mass cultures, (e.g., 5 ♀ ♂ × 5 ♀ ♂), at different parts of the year, an ample supply of nymphs of all stages will be available all the year round. This is clearly a great advantage since the gonads of young nymphs afford the most valuable material for cytological purposes. Mass cultures in which the generations have been allowed to overlap have now been kept unchanged for more than two years and still give nymphs in fair numbers.

In two cultures with a single female only the number of new hatched nymphs counted in the course of five months was 20 and 36 respectively. In a pair culture 14 new hatched nymphs were counted in three months. These counts do, however, not give a real idea of the productivity since quite a few nymphs were allowed to remain in the cultures, and it was later detected that even quite young nymphs may kill and eat their younger litter mates. In too crowded cultures of adult specimens the majority of emerging nymphs are probably disposed of by the old animals.

The shortest time interval recorded between the starting of a culture and the first emergence of nymphs was 2 1/2 months. In other cultures this period lasted for 3–3 1/2 months. The time required for attaining sexual maturity has not yet been determined, but the evidence so far obtained indicates that the time interval between two succeeding generation is at any rate less than one year.

Judging from a limited test Tachycines does not reproduce parthenogenetically.

The breeding technics has in the main remained unchanged. In addition to flower-pot cages are now also used cages made of wire gauze and zink-plates. Large cages for mass cultures of about 20 animals are of the following dimensions: 36 cm. × 22 cm. × 15 cm. (height); for pair cultures the dimensions are 21 cm. × 15 cm. × 15 cm. The bottom is made of a perforated zink-plate; to a height of 4 cm. the
lower part of the walls is made of unperforated zink. This zink container is filled with earth to a height of 3 cm. The roof of the cage is provided with a door, 10 cm. × 10 cm. The wire gauze should be very fine-meshed in order to prevent the new hatched nymphs from escaping.

Each cage is placed in a zink-dish that is somewhat larger than the bottom of the cage in question and provided with a 4–5 cm. high edge. A photo of some of these cages is presented in Fig. 2.

For food has now for a long time been used cabbage instead of salad. About 1/8 of a medium-sized ordinary cabbage-head is placed in the cage every five days. In order to prevent the lower part of the cabbage from decaying by contact with the moist earth the cabbage is placed in a low glass-jar. Every two weeks water is filled into the zink-dish until the earth is thoroughly moistened. The cages are always kept in the dark incubator mentioned above, at 23°C.

Individual specimens are easily caught in the following way: When they,—eventually after shaking the cage,—are sitting on the wall, a test tube is pushed over them. Slight movements of the tube will make them jump nearer the bottom of the test tube which may now be removed without the animal escaping. Etherization may eventually be carried out immediately by aid of a cotton plug with ether. If
all the grasshoppers should be removed from a cage, the entire cage is covered with a towel on which ether is dropped directly. The narcotized animals may easily be picked up by the hind legs.

**Notes on the cytology of *Tachycines asynamorus***

The gonads of *Tachycines* present all the well-known general advantages of the grasshopper material. The testis is made up of separate tubes which by walls of connective tissue are divided into cysts. In each particular cyst all the germ cells are practically of the same developmental stage. The youngest cysts are found near the blind end of the tube, the oldest near the opposite end where the sperm duct commences. This arrangement makes the seriation of consecutive stages in the spermatogenesis very simple and secure.

The chromosomes are very large and give excellent pictures by the ordinary methods of fixation and staining. A draw-back is involved in the fact that the diploid chromosome number is very high, viz., 57 in the male, 58 in the female sex. Of these chromosomes 56 are rod-shaped, telomitic autosomes. A big V-shaped, atelomitic chromosome which is simplex in the male, duplex in the female diploid cells represents the sex chromosome. The sex determination mechanism is accordingly of the XX–XO type typical of the locustids. Since the sex chromosome is much larger than, and differs in shape from all the autosomes the material is very valuable for demonstration purposes. As seen in Fig. 3 the X-chromosome lies always at the periphery of the equatorial plate.

Our findings with respect to the male chromosome equipment are fully in accordance with the results of SCHELLENBERG (1913). In the related species, *Diestrammena japonica* KARNY, MAKINO (1931) found chromosome relations which are strikingly similar to those encountered in *Tachycines*, viz. 56 rod-shaped autosomes and a large V-shaped sex chromosome that is simplex in the male, duplex in the female diploid cells.
In order to get an idea of the progress of the spermatogenesis, the femur and body lengths were measured in 23 young nymphs and compared with the stages reached in the germ cell development of the same individuals. On the whole the body length corresponds to the femur length in these stages, but since the latter is easier to measure only the femur length values are included in the following summary.

In 3 individuals with femur length 6-6.5 mm., average 6.3 mm., the oldest germ cells present were secondary spermatogonies. In 3 individuals, all with a femur length of 7 mm., the most advanced cells were in preparation for the leptotene stage. In 6 individuals with femur lengths between 7.2 and 7.8 mm., average 7.5 mm., the typical leptotene stage had been reached. In 10 individuals with femur lengths between 7.2 and 10 mm., average 8.4 mm., the oldest cysts contained cells that were in the pachytene stage. In one individual, finally, which had a femur length of 11 mm., young spermatids were present in the most distal cysts.

All those who in the spring and early summer have been collecting young grasshopper nymphs for cytological purposes will realize the great advantages involved in having an easy and inexpensive access to this material all the year round. That the material may also be useful for a variety of experimental purposes goes without saying. In dealing with problems such as the production of mutations by X-rays, the influence of external agencies on the different stages of gametogenesis, only to mention a few, the ample supply of control individuals is of course of particular importance.

Literature cited