

THE USEFULNESS OF NEW TAXONOMIC CHARACTERS
IN FEMALES OF THE GENUS *TETRANYCHUS* DUFOUR
(Acari : Tetranychidae)

BY

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In nearly all genera of the family Tetranychidae, it is possible to recognize species employing characters of the females. In some instances the nature of the aedeagus must be known for determination of species, but in the genus *Tetranychus* it has been necessary to observe males for species determinations. Females have been useful in this genus only to the extent that one could determine species groups, but in no case except *T. fijiensis* Hirst, *T. tumidosus* Baker and Pritchard and *T. viennensis* Zacher could females be recognized with certainty as to species. (PRITCHARD and BAKER, 1955, BAKER and PRITCHARD, 1960).

Our studies have demonstrated the possibility of employing the variations in cuticular lobes found in females of all species of the genus *Tetranychus* as an aid to separating species. A proper study of cuticular lobes is impossible unless proper mounting techniques are employed, and the worker observes the lobes only after they have been laid flat against the cover glass or slide. It is unfortunate that many type specimens cannot be studied for lobe characters because the original preparations are not suitable, and it seems impossible to improve them by remounting, since our attempts at remounting similar preparations have not been successful.

FIXATION.

The most satisfactory mounting medium we have used requires that the mites be first fixed in ethyl alcohol. Other fixatives have not been tested, but the necessary fixation involves a certain degree of hardening of tissues and the removal of color as it occurs in the living mite. The process is rapid (24 hours) using 95 per cent alcohol, but the specimens become somewhat hardened more than necessary and slightly brittle. Fixation with 70 to 80 per cent alcohol requires

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about 3 days for the mites to become colorless, but this can be hastened by holding the specimens at 45°C. In this case overnight is sufficient in most cases. This process does not clear the dark food material, and if PVA medium is used, they may not clear completely, but the presence of food spots does not usually interfere with observation of the lobes.

Since the lobes of females normally stand upright on cuticular ridges, it is necessary to make them lie flat with pressure. The resistance afforded by the slightly hardened body contents after alcohol fixation permits one to press on the coverglass while the medium is fluid, thus forcing the upright lobes into a horizontal position. Careful pressure must be applied so that the mite is somewhat flattened but not broken. The amount of pressure must be determined with practice. Living mites and mites mounted directly without fixation rarely permit the flattening of lobes because the body contents are too soft, and with PVA medium the color interferes with proper observation. Previously cleared mites, such as when cleared with lactic acid, cannot always be used for lobe study since there is nothing inside to resist the flattening pressure of the coverglass on the lobes. For other clearing details and staining methods, see DOSSE, 1961.

EMBEDDING MEDIA.

Workers in tetranychids mount their specimens in various kinds of media, the most popular of which is some modification of Berlese's medium, such as Hoyer's medium. Some of the chief advantages of Hoyer's medium are that mites clear rapidly, and slides can be hardened with heat without distorting the specimens. Disadvantages include impermanence, unless the mount is ringed before complete hardening, because drying out results in crystal formation; darkening; bubbles growing and destroying the mount; or softening after hardening in humid atmospheres. By comparison with a PVA medium we have used, Hoyer's medium does not produce as good phase contrast images.

The disadvantages of Hoyer's medium are adequately resolved by the use of a polyvinyl alcohol based medium as described by HEINZE (1952). The formula given below does not correspond with the formula published by HEINZE because of an error in printing 15 per cent instead of 1.5 per cent phenol:

- 10 g. Polyvinyl Alcohol
- 40-60 cc. Distilled Water
- 35 cc. Lactic Acid (85-92 %)
- 10 cc. Glycerine
- 25 cc. Phenol-Water Solution, 1.5 %
- 20 g. Chloral Hydrate

All ingredients must be of highest quality. The grade of PVA is not important, as long as a water solution can be prepared. Any PVA similar to Dupont Elvanol 71-30 is satisfactory. Larger batches can be prepared by increasing the amounts by a common factor.

Add the water to the PVA powder in a large beaker, stirring constantly, the mixture being heated in a water bath to just below boiling. To the PVA-water mixture, add the lactic acid and stir a few minutes. Then add the glycerine and stir again until smooth. Cool the mixture to lukewarm, and add the chloral hydrate dissolved previously in the phenol solution. After thorough stirring filter in a suction funnel through filter paper. Glass wool filtering is not satisfactory. The filtering will be slow, and may take a day. The Heinze-PVA medium should be stored in brown bottles.

Slide preparations using Heinze-PVA medium do not darken, remain hard after drying, need not be ringed, and produce no crystals or air bubbles. Specimens retain their normal form without the shrinkage or wrinkling so common in other PVA media. To avoid shrinkage, however, the slides must not be heated. They will dry hard enough for handling in 3 or 4 days at room temperature. Some disadvantages of this medium are : clearing is not as rapid or as thorough, and once the specimen has been flattened, it is impossible to change its orientation by skidding the coverglass, such as is necessary in observing the aedeagus of males. HEINZE reports its refractive index to be 1.515.

POSITIONING THE SPECIMENS.

Females. — The main taxonomically useful characters of females are those of the peritremes, the sensory structures of the palpus, the setation pattern of the tarsus I and the nature of the empodium of all legs, plus size, shape and distribution of cuticular lobes. Ordinarily a dorsal view and a lateral view have been all that was necessary. Because one must use oil immersion for studying the lobes, a ventral view is also highly desirable, especially if the female is of a large species. The older females are best to use because greater volume of the body contents has caused the maximum stretching of the cuticle, making it easy to press the lobes flat with a coverglass. Pressure is applied to the coverglass over the mite using a needle, and the mite must not be broken.

Males. — The proper orientation of the male tetranychid is lateral, because characteristics of the aedeagus are the most important single male characters. Many published figures suggest to us the possibility that reports of variability result from viewing the aedeagus at angles not quite perpendicular to the median plane. It seems to us of the utmost importance that before a decision of variability is reached, the observer must be sure that his views of the aedeagus are all strictly lateral. The only way to be sure of this is to position the aedeagus on a fresh mount while observing through the microscope, and seeing all the parts in focus at the same time. This is best accomplished by placing the male in a small drop of medium, so that a very thin layer of medium will fill the space under the coverglass, and allowing some clearing to occur for 5 or 10 minutes before placing the coverglass on the medium. This will permit sliding the coverglass

and rolling the male to a proper position before flattening. If one uses Hoyer's medium, the positioning of the male is easier because the tissues become softer in a shorter time. In using Heinze-PVA, if the male is not properly positioned at the first try, it is nearly impossible to change the orientation after flattening.

NECESSARY COLLECTION DATA.

In addition to information concerning date, host plant and collector, we feel that use can be made of additional data. The color of the adult summer females is in *Tetranychus* either reddish, reddish brown, green, yellowish green. As far as we know, each color is consistent for each species, to the extent that some species are reddish and others are greenish. The shade of green or red may be affected by nutritional conditions, or age, but adult red reproducing mites are always reddish. In the fall and winter, species of this genus undergo a winter diapause in colder temperate climates, and as far as is known, the females become orange or orange-red in color, lose the typical lateral food spots and the lobes, and seek shelter either on bark, under webbing or in ground trash.

LOBES.

Definition. — Earlier workers have mentioned "striae" on the cuticle of mites, and use was made of the striation patterns in taxonomy. Some have described the striae as broken or smooth. The broken appearance of the striae is the result of the fact that the striae are really cuticular ridges. These ridges are largely unbroken in young mites, males and diapausing females. In active adult females, the ridges are incised at intervals so as to form lobes. The apparent height of the lobes depends upon the depth of the incisions. These incised ridges occur on the dorsum and sides of all species we have studied, but they may be absent medioventrally on all or part of the venter. Since there is some variation in lobing dorsally compared with laterally, the mediodorsal hysterosoma might be used for a standard dorsal area.

Lobe-shape. — If the cuticular ridges are not incised, they have the nature of a very thin vertical sheet, and in such a case lobes are absent. If the incisions are relatively far apart, the lobes will appear broad. This is generally the case with medioventral propodosomal lobes. When the incisions are closer together, the lobes may appear semicircular to triangular with rounded or relatively pointed apices. In some cases the incisions may be so close together that the lobes are very narrow compared to their height. In addition to the shape variations, some species bear visible dense spots at the base of each lobe.

Body Regions for Observing Lobes. — For observing dorsal lobes we have used the specific area bounded by the second and third pair of dorsomedial hysterosomal setae as defined by PRITCHARD and BAKER (1955, p. 10). In some species

the rhomboid area just posterior to the third dorsomedial hysterosomal setae bears lobes which are very similar to those ahead, and these can sometimes be used.

Ventrally, two areas are important. The hysterosoma between the three pairs of hysterosomal setae may be free of lobes, may bear lobes only between the first and second pair of setae, may bear lobes only between the second and third pair of setae, or may bear lobes over the entire area. The second area is the medioventral region anterior to the first pair of medioventral hysterosomals forward to and slightly surpassing the single pair of propodosomal setae. In this area lobes may be entirely lacking, or present as weak lobes near or just ahead of the propodosomal setae, or be present over the entire propodosomal venter. If the propodosoma bears lobes ventrally, the hysterosoma always bears lobes. If there are no hysterosomal ventral lobes, there never are propodosomal lobes. We have rarely observed lobes on the hypostome.

PRITCHARD and BAKER (1955) illustrated lobes for two species of *Oligonychus*, but made no comment. Lobes were first used as an aid in recognizing species by BOUDREAUX (1956), and since then these have been studied by many workers, and have been included in the description of some mites by BAKER and PRITCHARD (1960). WAINSTEIN (1960) stated that they are useful stable characters. However, VAN DE BUND and HELLE (1960) indicated that the lobes were not as well developed in young females as in older females of *T. telarius* (Linne) (= *T. urticae* Koch) and of *T. cinnabarinus* (Bois.). We have shown that the variations observed by these authors are most probably because of improper angle of observation, and that the actual shape of lobes does not change with age of the individual within any instar (DOSSE and BOUDREAUX, 1962). However, each nymphal stage may have weakly developed lobes, different from the imago, and in certain areas of the body only. Figure 6 shows the appearance of dorsal lobes viewed on edge.

DESCRIPTIVE TREATMENT.

The following descriptions are primarily additional morphological features which should aid in the recognition of species. For additional details and keys, see PRITCHARD and BAKER (1955), and BOUDREAUX (1956). Unless otherwise stated, dorsal lobes are those on the transverse striae just anterior to the rhomboid area, and the third dorso-medial hysterosomal setae.

Tetranychus schoenei McGregor, 1941, *Proc. Entomol. Soc. Wash.*, 43 : 223.

Lobes are borne on the dorsal and lateral striae of females, but are absent on the entire venter. Dorsally, the lobes are small, rounded, occasionally somewhat broad (Fig. 1). The lobes of females collected in mid-winter were more uniform than those of third generation descendents reared under continuous light at room temperature (70° to 85° F.). The laboratory-reared mites tended to have

narrower lobes. We studied Louisiana specimens only, from strawberry. Summer females are always some shade of green or yellow, and bear four distinct dark food spots.

Tetranychus ludeni ZACHER, 1913, *Mitt. Kais. Biol. Anst. Land-Forstw.*, 14 : 40.

The dorsal lobes of females are small, narrow and somewhat pointed at the tip, and separated by spaces at the bases (Fig. 2), closely resembling those of *T. cinnabarinus*. Ventrally, lobes are broad and low, becoming broader and lower anteriorly. They are rounded and some bear a small spot at the base on the hysterosoma, and are more pointed on the lateral venter. These lobes are found anteriorly to a point just past the ventral propodosomal setae near the hypostome. Specimens taken from December through March in Louisiana and Texas, and in mid-summer from Brazil all resembled each other closely.

We were not able to study the lobe form of females from California because of improper preparations. However, the male from California (Fig. 3) differed remarkably in the shape of the aedeagus compared with Louisiana and Brazilian specimens (Fig. 4). In the California male the posterior surface of the hook of the aedeagus bears a small spine-like process directed caudo-ventrally, while in the others this small process seems to be applied closely against the neck. Also, in these specimens, the surface of the barb is very slightly elevated as a barely visible bump, which is not visible in the California specimen. The terminal sensillum of the palpus of the California male is longer and narrower than in other forms, and the empodial spur on pretarsus I is longer. Our specimens were from *Lantana* sp., *Modiola carolinensis*, *Mentha* sp., *Erigeron* sp., *Stellaria* sp., and from Brazil on *Nicandria physaloides*, and from California on orchids. Summer females are always carmine red.

Tetranychus mcfarlandi BAKER and PRITCHARD, 1960, *Hilgardia*, 29 : 537.

The dorsal lobes of females are small, mostly round, with a few which tend to be pointed, and rarely broader than tall as in those of *T. neocaledonicus* (Fig. 8) but they are smaller and more uniform. In the rhomboid area of striae, the lobes are more variable, with more of them pointed. Ventrally the lobes are broad and rounded on the hysterosoma, and extend forward to the hypostome, where they are much broader and lower. Specimens studied were dried specimens cleared with lactic acid, from India, on vegetables. The label on the alcoholic specimens indicated that summer females are green.

Tetranychus tumidus BANKS, 1900, *U. S. Dept. Agric. Tech. Ser.*, 8 : 73.

The large dorsal lobes resemble those of *T. tumidellus* (see Fig. 5) in bearing a dark basal spot on most lobes, but among the semicircular lobes are some which either are narrower or are pointed terminally. The pointed lobes are more dense

near the point (see Fig. 15). Ventrally the lobes are small or large, or semicircular or very broad, some of which bear large or small basal spots. These extend from the genital plate to slightly past the ventral propodosomal setae, into the base of the hypostome. The males are pinkish, but not as bright red as are those of *T. tumidellus*. Specimens studied were taken from Banana in Baton Rouge. The type specimens cannot be studied because of the poor quality of the preparations. Summer females are dark carmine.

Tetranychus tumidellus PRITCHARD and BAKER, 1955,
Pac. Coast Entomol. Soc. Mem. Ser. 2, 409.

The dorsal lobes are large, semicircular, and fairly uniform. There are occasional narrow pointed lobes. Each large lobe bears a distinct dark spot at the base (Fig. 5). The illustration depicts one of six structures which we have seen on all females of the genus. These seem to be cuticular pores, but their internal relations are unknown. Investigations are in progress in Germany to determine their nature. These are located on each side slightly anterior and lateral to the second and third dorsolateral hysterosomal setae and the outer sacred setae.

The ventral lobes are nearly similar to the dorsal lobes, but are larger medially, and tend to be rather broad anteriorly. These extend well into the hypostome where they are very small and obscure.

We have cultured this species for many generations on bean, and the shape of the lobes did not change over six generations under long day conditions compared with the original collection made January 4, 1962, or with later collections in February and March from the same violets. A remarkable feature of this species is the deep red color of the females, and especially the bright red color of the males. The eggs are also distinctly reddish. We do not know of any other *Tetranychus* species with such highly colored males. In addition to the colony mentioned above, we have studied paratype specimens, whose condition is too poor for proper study.

Tetranychus gloveri BANKS, 1900, *U. S. Dept. Agric. Tech. Ser. Bull.*, 8 : 76 ;
BOUDREAUX, 1958, *Ann. Entomol. Soc. Amer.*, 51 : 174.

The dorsal lobes are somewhat triangular, with a few rounded lobes. The triangular lobes suggest a gothic shape, with the point much more dense as if with a dark cap (Fig. 9). Anteriorly the lobes are more rounded. Each dorsal lobe bears a basal spot as in Fig. 5.

The ventral lobes are rounded on the hysterosoma, as in Fig. 5. The propodosomal ventral lobes are semicircular to very broad and extend forward just past the bases of coxa I. Lobes also cover the basal $3/4$ of the coxae. The males are slightly reddish, as in *T. tumidus*. Bank's types cannot be studied for lobes because of their poor condition. Our specimens are of the same series as those

deposited by BOUDREAUX in the U. S. National Museum, from water hyacinth. Summer females are dark carmine.

Tetranychus magnoliae BOUDREAUX, 1954, *Pan-Pac. Entomol.*, 30 : 184.

Dorsal lobes are large and broadly triangular with very dense tips, the dark tips more prominent than in Fig. 9. There are no spots basally. Ventrally, the striae bear no lobes. Specimens were studied from *Magnolia grandiflora* and from *Magnolia soulangeana*. On the latter host the mites were on the under side. The dense hairs on the underside of the *M. grandiflora* apparently forces them to colonize the upper surface. A colony was maintained with difficulty on bean, and development was very slow. These cultured mites after several generations still possessed the same lobe type as those taken outside. Summer females are carmine.

Tetranychus cocosinus BOUDREAUX, 1954, *Pan-Pac. Entomol.*, 30 : 182.

This mite is unique among the ones we studied in having dorsal lobes completely different from those in and around the rhomboid area. The dorsal lobes are narrow, high and triangular, separated at the bases (as in Fig. 2), while those in and around the rhomboid area are broadly semicircular (Fig. 7). All the lobes bear dense areas at the tips. There are no ventral lobes.

Mites collected from *Rubus* sp. on Feb. 1, 1962, at Albany, Louisiana, were studied, and a culture of these was maintained on bean. There was no change in the nature of the lobes after four generations at summer photoperiods. Summer females are carmine.

Tetranychus merganser BOUDREAUX, 1954, *Pan-Pac. Entomol.*, 30 : 181.

Dorsal lobes of this species resemble those shown in Fig. 9, but are larger and broader at the base. A small area surrounding the third mediodorsal hysterosomal setae bears broad semicircular lobes, in contrast to the pointed dorsal lobes elsewhere.

The hysterosoma ventrally bears small, broad, rounded lobes. The propodosoma bears very few quite wide lobes, hardly more than an occasional incision on the striae, but around the propodosomal setae broad rounded lobes are apparent.

Specimens studied were collected from *Ligustrum* sp., *Jasminum* sp., *Fragaria* sp., and from corn in a greenhouse. Summer females are carmine.

Tetranychus neocaledonicus ANDRÉ, 1933, *Bul. Mus. Nat. Hist. Nat.* (Sér. 2) 5 : 302.

The dorsal lobes are rounded, and bear basal spots as in *T. tumidellus*, but they are smaller and of different sizes (Fig. 8). There is an occasional broad lobe

or a small one among the typical semicircular ones. Ventrally lobes are absent, except for small fields in the spaces between the first and second, and the second and third medioventral hysterosomal setae. These are obscure, very low and broad. We have not observed any male with an aedeagus as pictured by PRITCHARD and BAKER (1955) (called *T. cucurbitae* Rahman and Sapra), but all those we studied were as illustrated in BAKER and PRITCHARD (1960). This carmine species was studied from Florida specimens.

Tetranychus lobosus BOUDREAUX, 1956, *Ann. Entomol. Soc. Amer.*, 49 : 46.

There is evidence that there may be distinct strains in this species which differ in lobe form, and which are somewhat genetically different as revealed by test crosses. As originally described, *T. lobosus* bears triangular narrow dorsal lobes, with rounded to broad ventral hysterosomal lobes, and bears no trace of lobes on the ventral propodosoma. We have not recovered, in this study, any mites which conform to the original description.

A strain consisting of three stocks, one from corn in a greenhouse, another from *Modiola carolinensis* and a third from cotton, all from Baton Rouge, differs from the original in bearing broad triangular dorsal lobes, interspersed with occasional rounded lobes (Fig. 9). Toward the sides and near the eyes lobes become semicircular, bearing a dark spot on the base of each. Ventrally the hysterosomal lobes resemble the original in being short and round, and they are broader posteriorly. In addition there are very broad lobes ventrally on the propodosoma, which are hardly more than the result of an occasional incision of the striae near the propodosomal setae. The aedeagus of males has a larger anterior angulation on the knob (Fig. 10) than does that of the holotype (Fig. 11). These three stocks were completely interfertile when crossed.

The third strain, collected from strawberry in Hammond, La., *Modiola carolinensis* and *Lonicera* sp. in Houston, Texas, and *Fragaria* sp. in New Orleans, Louisiana, bears a different type of lobe structure. Dorsally the lobes are larger, rounded and nearly uniform, bearing each a basal spot (Fig. 12). Ventrally the hysterosomal lobes are similar to the dorsal lobes, but tend to be rather broad. The ventral propodosomal lobes are clear cut, and are prominent anteriorly near the setae in contrast to their absence in the type specimens and their obscurity in the other strain. The aedeagus resembles that of the second strain. The "Fragaria" strain was interfertile with the second strain in all combinations except in "Fragaria" ♂ × "Modiola" ♀ from Baton Rouge, in which most of the F₁ hybrid eggs were inviable, as also were many eggs of the second generation. The collection from New Orleans of *Fragaria* contained some specimens with lobes as in the second strain.

Since the original specimens of *T. lobosus* were collected in summer, and the strains we studied are winter collections, it occurred to us that lobe differences might be under photoperiodic control. The "Fragaria" strain was cultured for

four generations under summer laboratory conditions, and as a result there was only a very small change in lobe form towards smaller size. In view of this and the test cross results, it is felt that this is a genetically distinct strain. The females of this species are carmine.

Tetranychus telarius (Linné, 1758) (partim) BOUDREAUX, 1956,
Ann. Entomol. Soc. Amer. 49 : 44.

The name of this species is in question, but we discuss here the species as defined in the title. It is presently known elsewhere as *T. urticae* Koch (PARR and HUSSEY, 1960 and VAN DE BUND and HELLE, 1960).

The dorsal lobes of females are mostly large, rounded, with some rather oblong, and others narrower with an occasional pointed lobe (Fig. 13). Ventrally lobes generally are lacking (Fig. 14). However, in all strains, small lobes were observed ventrally between hysterosomal setae I and II. We have examined strains from Louisiana, Massachusetts, England, Germany and Japan, and all are similar. The summer females of this species are always some shade of yellow or green.

Tetranychus cinnabarinus (BOISDUVAL, 1867), *Essai sur l'Entomol. Hort.*, p. 88.
Acarus haematodes (BOISDUVAL, 1867), *Essai sur l'Entomol. Hort.*, p. 88
(new synonymy).

This species, as here discussed, was defined by BOUDREAUX (1956). The dorsal lobes of females are typically very narrow, relatively pointed and separated at the bases (Fig. 15, 16, 17, 18). The Hawaiian strain bears more broadly triangular lobes dorsally. Ventrally no lobes appear, except that there are obscure lobes in the area between the first and second pair of hysterosomal setae, as in *T. telarius*. We have examined strains from Louisiana, Maryland, California, Hawaii, Germany and England. The summer females are carmine.

The Males of *T. cinnabarinus* vs. *T. telarius*.

The aedeagal characters of the males of *Tetranychus* have been most useful as a specific character. However, after studying all available specimens of males of the two last species above it is evident that no clear cut distinctions can be made between *T. telarius* and *T. cinnabarinus* studying only the aedeagus. Each species exhibits variations which occur in the other species (Fig. 19, 20). Therefore the only clear distinctions between the two species are found among the females. The females of *T. telarius* are some shade of green or yellow, and dorsally bear lobes as in Figure 13. The eggs are always clear when first laid. Usually the live females bear two large distinct dark food spots, but there may be four such spots in older females. The females of *T. cinnabarinus* are some shade of red when mature, and dorsally bear lobes as in Figure 18. The eggs are usually tinted

reddish when first laid, but some may lay clear eggs. Usually the live females bear four distinct dark food spots. In both species the body ahead of the eyes is yellowish.

LOCAL STRAINS AND HYBRID POPULATIONS.

The apparent variation in lobe characters described above provides an interesting problem concerning the cause of such variety. If such variation is under genetic control, the logical explanation of finding variants in the same colonies would be on the basis of heterozygosity in the populations. There is not much experimental evidence yet for this explanation of lobes, but the condition should not be unexpected since genetic variation is well known in the case of mite resistance to acaricides (TAYLOR and SMITH, 1956).

The possibility of variation of lobe shape as a seasonal phenomenon has been suggested by the known effect of combinations of short photoperiod, low temperature and poor food resulting in the loss of lobes in females which eventually go into diapause. As an example, *T. lobosus* collected from strawberries in February all exhibited semicircular dorsal lobes. A culture from this population held for 4 generations at a 14 hour daily photoperiod yielded females with somewhat narrower rounded lobes. A collection from the same locality in late March had some females with semicircular lobes, and other females had narrower lobes, more nearly like those originally described in this species. Whether the variation is under strict genetic control, or is in part controlled by seasonal changes, is unknown.

An indication of genetic control of lobe shape was found by MONROE (1962). She produced largely sterile hybrids between two species, using the common two-spotted mite which she called *T. telarius* (L.), and the carmine mite, *T. cinnabarinus*. *Tetranychus telarius* has broad rounded lobes as described above, and *T. cinnabarinus* has narrower more pointed lobes dorsally. The hybrids bore dorsal lobes of intermediate form, consisting of a mixture of types. The few fertile hybrids produced a second generation of back crosses whose lobe characteristics approached those of the male parental type used with the F_1 hybrids. When male offspring of F_1 hybrids were crossed with second generation females, the female offspring bore lobes of various types, some similar to *T. telarius*, others as in *T. cinnabarinus* and others with mixtures.

We have studied the lobes of stocks of *T. telarius* sent us from greenhouse cultures in Oklahoma. When received, the cultures contained some females with diapause morphology (orange, without lobes), some with the appearance of *T. telarius* others appearing to be *T. cinnabarinus* with *T. telarius* lobes, others more typical of *T. cinnabarinus* and others yet which resembled Monroe's hybrids, not only in morphology, but in laying inviable eggs. From our studies it is apparent that the original stocks of green *T. telarius* were contaminated by the accidental invasion of *T. cinnabarinus*, with which it interbred. It must be pointed out that interspecific hybridization produces sterile hybrids as a rule, while fertile

hybrids are extremely rare (BOUDREAUX, 1956, DILLON, 1958, HUSSEY and PARR, 1959, 1960, VAN DE BUND and HELLE, 1960, BOUDREAUX and DOSSE, unpublished data). Present evidence indicates that such rare fertile hybrids may introgress into the parent species and produce a hybrid swarm of good fertility after a few generations. From the Oklahoma mixture, we have segregated by selection three distinct lines. One of these is typical of *T. cinnabarinus*, another resembles *T. cinnabarinus* in being red, but the eggs are clear and the dorsal lobes are like those of *T. telarius*. In addition, the young females of this line are greenish for a while before becoming red. A third line has features mostly of *T. cinnabarinus*, but the lobes are of a mixed type. Some lobes are broad, others are semicircular and others are narrowly triangular.

More recently we received for identification alcoholic specimens from cotton in a greenhouse in Alabama, described as "predominantly red." Slide preparations revealed the same types as we found in the Oklahoma mites. It would seem that greenhouses afford excellent opportunity for interbreeding to occur. It might be that the reason for the poor morphological separation of some European strains of *T. cinnabarinus* and *T. telarius* (*T. urticae* of European workers) is that there may have been hybridization and introgression at some undeterminable earlier date.

On the other hand, there seem to be some species in which the shape of the lobes is quite constant, regardless of season. This is the case in all specimens we have seen of *T. tumidellus* P. & B., *T. cocosinus* Boudreaux, *T. magnoliae* Boudreaux, and of *T. ludeni* Zacher from Louisiana compared with the same species from Brazil at the same time of year (winter in Louisiana, summer in Brazil).

In 1952, DOSSE discussed a form on carnations in greenhouses which was named *T. urticae* Koch forma *dianthica*. We have studied this form in the light of our knowledge of lobes, and it exhibits characteristics which seem to differentiate it from both *T. telarius* and *T. cinnabarinus*. It is a brownish red form with four dark food spots, but the dorsal lobes are very similar to those of *T. telarius* as shown in Figures 21 and 22. There is no trace of lobes ventrally. Breeding tests with other species are in progress, and its specific status is unknown at the moment.

CONCLUSIONS.

The results of this study demonstrate that to some extent the lobes are useful taxonomic characters. If groups were separated on the basis of lobe characters, an entirely different arrangement would be obtained from the species groups of PRITCHARD and BAKER (1955), which were elevated to subgeneric rank by WAINSTEIN (1960). We are of the opinion that Wainstein's subgenera are largely artificial because they are based upon combinations of too few characters, such as the nature of the empodium. However, the three species *T. tumidus*, *T. gloveri* and *T. tumidellus* are quite closely related in being large, the females bearing

large lobes with basal spots, having extensive lobing ventrally, bearing heavy terminal sensilla on the palpus, having large empodial spurs, and in the males being reddish, and having similar aedeagal knobs which differ only in size.

It is noteworthy that all the species collected in Louisiana were found thriving in midwinter with no indication of diapause.

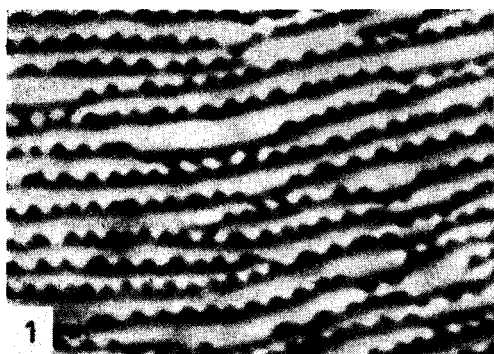
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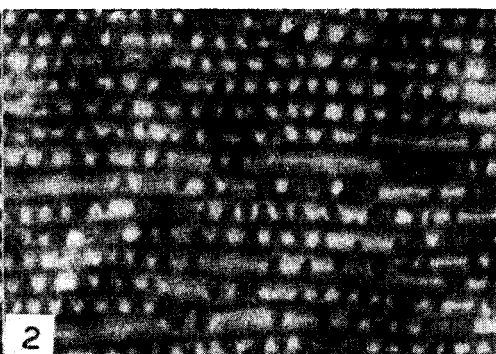
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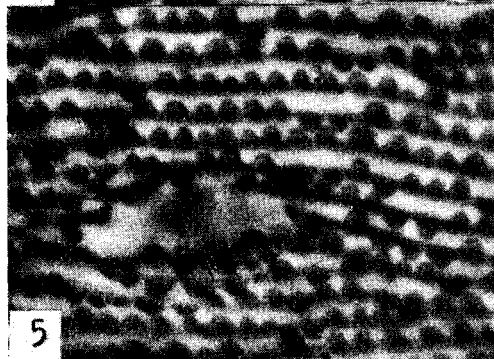
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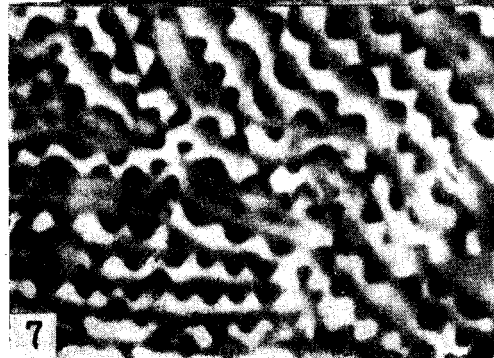
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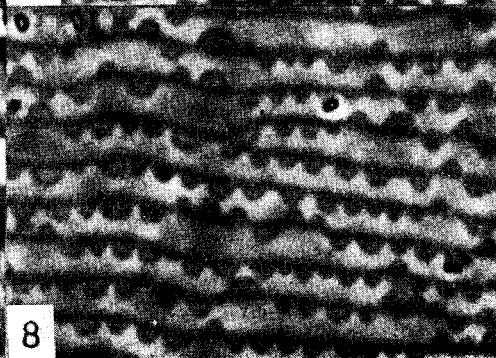
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lipoma

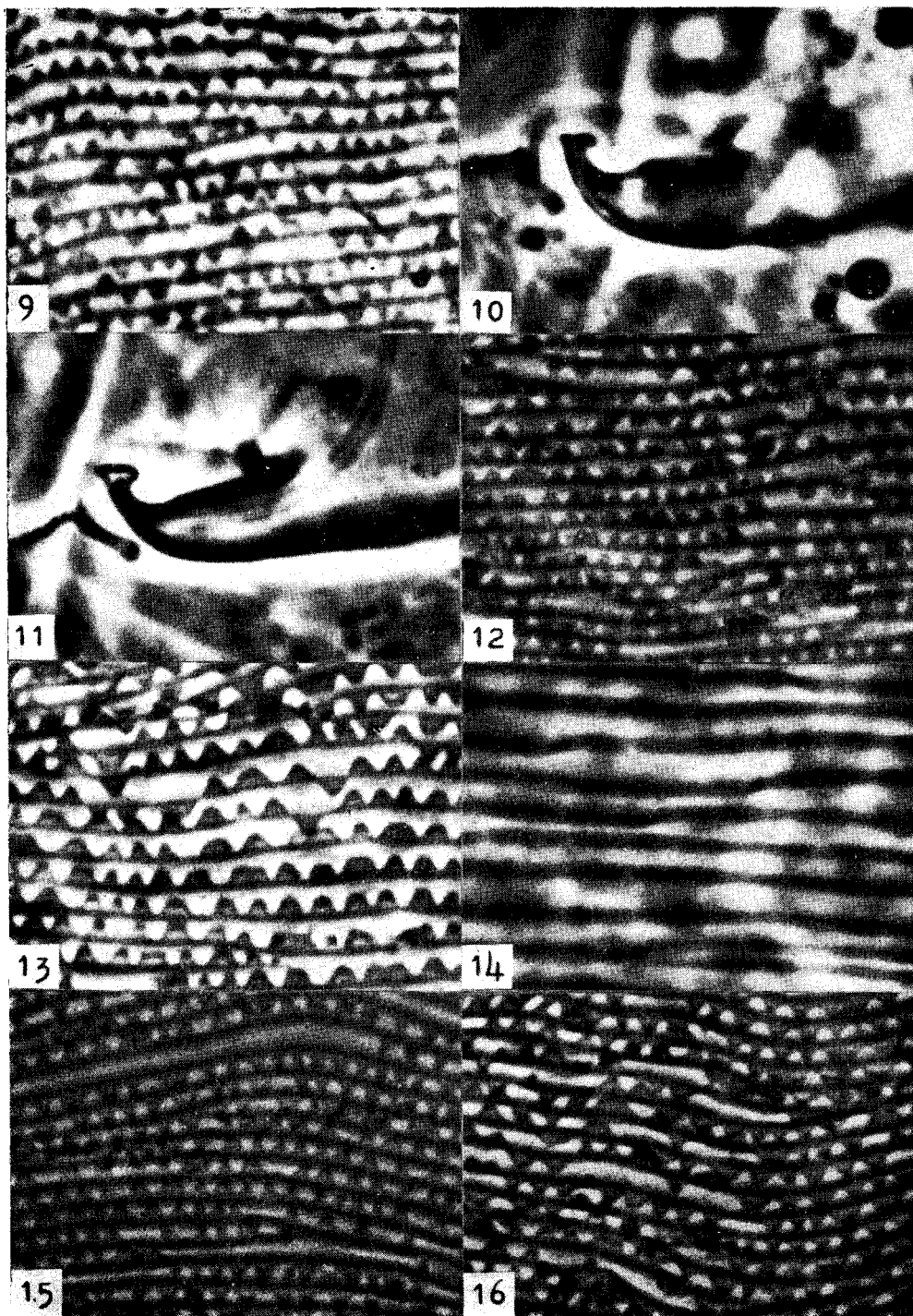
lipoma
(*lipoma*)

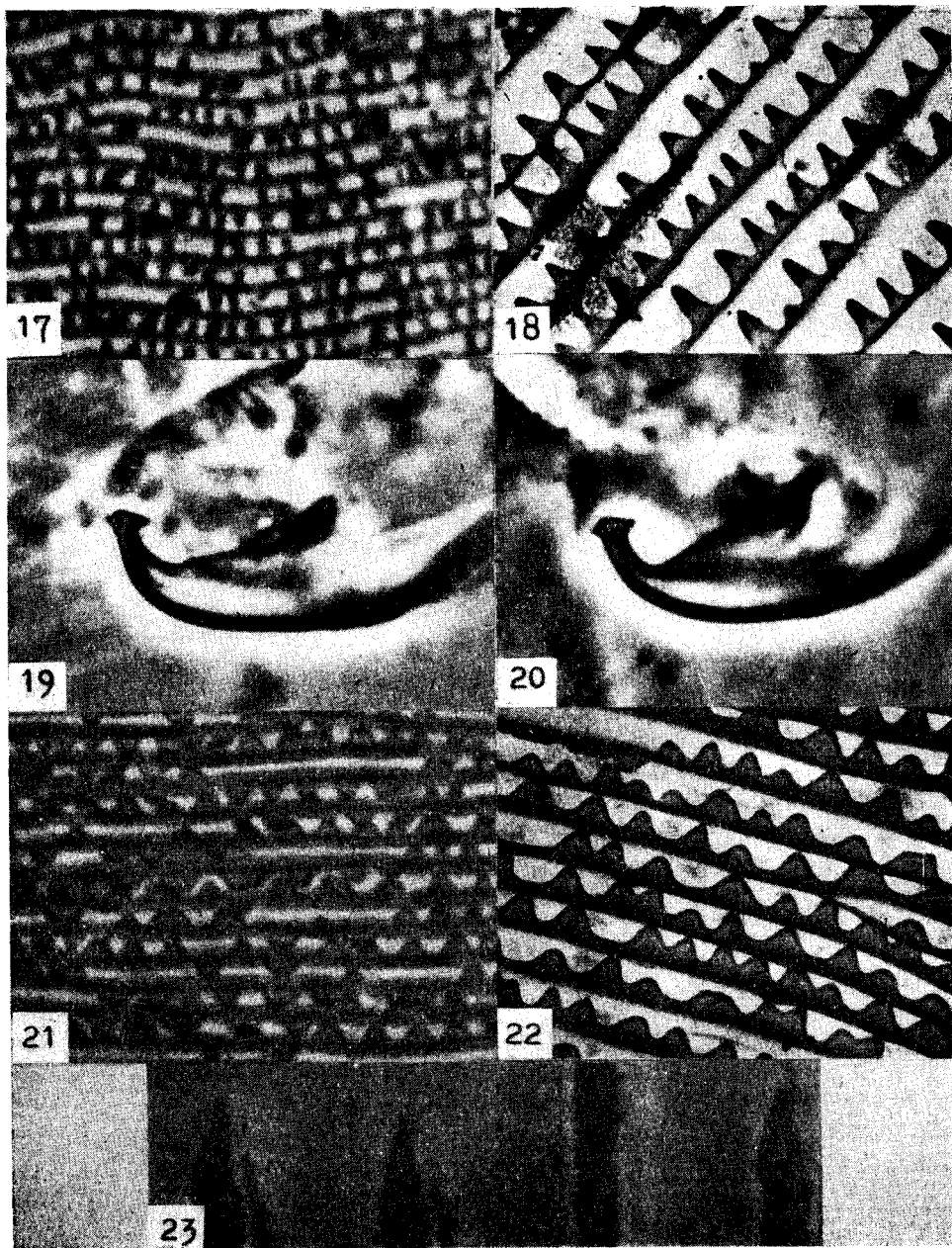
midline

midline

lines

neocodons





*Pinus
bambusa*

*Pinus
bambusa*

*Pinus
bambusa*

*Cinnyra
Ptilinopus
leucophaea*

*Ptilinopus
leucophaea*

*Ptilinopus
leucophaea*

23

EXPLANATION OF FIGURES

All magnifications are X2500, except Figures 18 and 22, which are approximately X6000.

- FIG. 1. — Dorsal lobes of female of *T. schoenei* from Louisiana.
FIG. 2. — Dorsal lobes of female of *T. ludeni* from Louisiana.
FIG. 3. — Aedeagus of male of *T. ludeni* from California.
FIG. 4. — Aedeagus of male of *T. ludeni* from Louisiana.
FIG. 5. — Typical dorsal lobes of female of *T. tumidellus* from Louisiana, with cuticular „pore.”
FIG. 6. — Typical appearance of lobes viewed on edge when improperly prepared, *T. tumidellus*.
FIG. 7. — Rounded lobes of female of *T. cocosinus* in and slightly anterior to rhomboid area. Louisiana specimen.
FIG. 8. — Dorsal lobes of female of *T. neocaledonicus* from Florida. •
FIG. 9. — Dorsal lobes of female of *T. lobosus* from Louisiana on cotton.
FIG. 10. — Aedeagus of male of *T. lobosus* from corn, Louisiana.
FIG. 11. — Aedeagus of holotype male of *T. lobosus*.
FIG. 12. — Dorsal lobes of female of *T. lobosus* from strawberry, Louisiana.
FIG. 13. — Dorsal lobes typical of females of *T. telarius*. From rose, Louisiana.
FIG. 14. — Ventral striae of *T. telarius*, illustrating absence of lobes.
FIG. 15. — Dorsal lobes of female of *T. cinnabarinus* from tomato, Louisiana. •
FIG. 16. — Dorsal lobes of female of *T. cinnabarinus* from Hawaii. •
FIG. 17. — Dorsal lobes of female of *T. cinnabarinus* from Germany. •
FIG. 18. — Electron micrograph of dorsal lobes of female of *T. cinnabarinus* on *Ricinus*, from Spain, X6000. (Made in Germany).
FIG. 19. — Aedeagus of male of *T. cinnabarinus* from Germany. •
FIG. 20. — Aedeagus of male of *T. telarius* from Germany.
FIG. 21. — Dorsal lobes of female of *T. urticae* forma *dianthica* from Germany.
FIG. 22. — Electron micrograph of dorsal lobes of *T. urticae* forma *dianthica*, X6000. (Made in Germany).
FIG. 23. — Photograph of micrometer enlarged to same scale as all figures (except Figures 18 and 22). Each division = 0.01 mm.