ve cuy. 6175

Recent Advances in Acarology, Volume II

KARYOTYPES OF THE TETRANYCHIDAE AND THE SIGNIFICANCE FOR TAXONOMY

J. Gutierrez

Laboratory of Applied Zoology
Centre ORSTOM de Noumea, New Caledonia

H. R. Bolland and W. Helle

Laboratory of Experimental Entomology
University of Amsterdam, The Netherlands

m do HO

INTRODUCTION

In addition to earlier reports on karyotypes of Tetranychidae (Helle and Bolland, 1967; Helle *et al.*, 1970; Gutierrez *et al.*, 1970; Gutierrez and Helle, 1971; Gutierrez and Bolland, 1973 a, b), 15 other species of this family have been studied in the past years, bringing the total number of species examined with regard to chromosome number to nearly 80. This figure forms a relatively small part of the total of the species described. Nevertheless, the available data give rise to some comments which may be of interest to the taxonomist.

Numbers of tetranychid chromosomes range between $n = 2$ to $n = 7$. The numbers $n = 2$, $n = 3$ and $n = 4$ are commonly found, with $n = 3$ being the modal number. The higher numbers are less frequent. With respect to the modal number $n = 3$, however, it should be noted that most data are obtained from species of the more advanced genera, and that a sampling error might be involved. For the more primitive subfamily of the Bryobiinae Berlese the figure of $n = 3$ has not been found yet: the 11 species examined of the genera *Bryobia, Porcupinychus, Tetranycopsis, Petrobia, Schizonobia* and *Tetranychina* have either $n = 2$ or $n = 4$.

The number of $n = 2$ has been postulated as being the ancestral number of the Tetranychidae, mainly because of its occurrence in the more primitive Tenuipalpidae (Helle *et al.*, 1972; Helle and Bolland, 1972), another family of the superfamily Tetranychoidea. Reports on karyotypes of species from other prostigmatic families often mention low numbers (for references see Oliver, 1977). In the haplodiploid species *Neophyllobius elegans* Berlese from the related superfamily Raphignathoidea, the rather high number of n = 11 was found (Bolland and Helle, unpubl.).

The chromosome number of a species seems to be constant, since populations from different geographical origins show similar karyotypes. It was also found that closely related species have the same number. The chromosome numbers of species within a genus, however, may sometimes vary considerably.

With the normal staining methods, the very small chromosomes of tetranychid mites do not display peculiarities or charactertistics, which can be used for identification or for studies on homology. For *Tetranychus urticae* Koch it has been shown by Pijnacker and Ferwerda (1972) that the chromosomes are holokinetic, and it may be taken for granted that the chromosomes of all Tetranychoidea are diffuse-centric (see also Pijnacker and Ferwerda, 1975, 1976).

All bisexual species of Tetranychidae appear to be haplo-diploid. From several dozens of species, including five species of Bryobiinae, virgin females have been isolated in order to assess the parthenogenetic orgin of the haploid (male) eggs. This kind of rearing evidence for arrhenotokous (haploid) parthenogenesis, has been obtained for species of the genera *Bryobia, Porcupinychus, Tetranychina, Schizonobia, Eurytetranychus, Eutetranychus, Aponychus, Duplanychus, Eonychus, Eotetranychus, Neotetranychus, Panonychus, Schizotetranychus, Oligonychus* and *Tetranychus*, so that it may be concluded confidently that arrhenotoky is underlying the haplo-diploid situation of the whole family. Thelytoky is very common in the subfamily of the Bryobiinae, but extremely rare in the subfamily of the Tetranychinae Berlese (Gutierrez, 1977).

NOTES WITH REGARD TO TAXONOMY

Two genera, *Oligonychus* and *Tetranychus*, deserve attention with regard to taxonomic considerations. Both genera have been substantially arranged and delineated by Tuttle and Baker (1968). Since a considerable number of species of both genera have been examined with respect to chromosome number, it is opportune to include this kind of information. In Table I, the 18 *Oligonychus* species have been grouped together, according to the subgenera described by Tuttle and Baker (1968). They belong to the subgenera *Reckiella* Tuttle and Baker, *Oligonychus* Berlese *s.str.* and *Pritchardinychus* Wainstein. No cytogenetic data are available concerning the subgenera *Wainsteiniella* Tuttle and Baker, *Homonychus* Wainstein and *Metatetranychoides* Wainstein.

Immediately noticeable is the gap which exists between the first 4 species, in Table I all with 2n = 4 and the 8 following, which have 2n = 8. The former belongs to the section *Mcgregorellus* Wainstein, 1960, called the *Mcgregori* group by Pritchard and Baker (1955), the latter to the section *Pratensellus* Wainstein, 1960, called the *Pratensis* group by Pritchard and Baker.

TABLE I.
Chromosome Numbers in 18 Different Species of the Genus *Oligonychus* Berlese.
((R.) = Subgenus *Reckiella* Tuttle and Baker; (O.) = Subgenus *Oligonychus* Berlese *Sensu Stricto;*
(P.) = Subgenus *Pritchardinychus* Wainstein).

Species	Geographic Origin of the Strain	Host Plant	Number of Chromosomes	
			2n	n
Oligonychus (R.) andrei Gut.	Madagascar	*Grewia lavanalensis*	4	2
O. (R.) gossypii (Zacher)	Madagascar	*Grangeria* sp.	4	2
O. (R.) grewiae Meyer	Madagascar	*Croton* sp.	4	2
O. (R.) sylvestris Gut.	Madagascar	*Sida rhombifolia*	4	2
O. (R.) bessardi Gut.	Madagascar	*Oxalis corniculata*	8	4
O. (R.) chazeaui Gut.	Madagascar	*Hyphaene shatan*	8	4
O. (R.) gramineus (McGregor)[a]	N. Caledonia	*Panicum maximum*	8	4
O. (R.) grypus B. and P.	Madagascar	*Panicum maximum*	8	4
O. (R.) leandrianae Gut.[a]	Madagascar	*Brachiaria leandriana*	8	4
O. (R.) plegas B. and P.[a]	Mauritius	*Cocos nucifera*	8	4
O. (R.) pratensis (Banks)	Madagascar	*Dactyloctenium capitatum*	8	4
O. (R.) virens Gut.	Madagascar	*Melinis minutiflora*	8	4
O. (O.) coffeae (Nietner)	Madagascar	*Vitis vinifera*	6	3
O. (O.) quercinus Hirst	The Netherlands	*Quercus robur*	6	3
O. (O.) punicae (Hirst)[a]	U.S.A.—California	*Avocado* sp.	4	2
O. (O.) thelytokus Gut.[a]	Madagascar	*Cotoneaster* sp.	6	—
O. (O.) ununguis (Jacobi)	Finland	*Juniperus communis*	6	3
O. (P.) pemphisi Gut.	Madagascar	*Pemphis madagascariensis*	6	3

[a] New record.

These two groups can be morphologically recognized by the empodium I of the male, composed of one claw and three pairs of proximoventral setae in the former, of one claw and one pair of proximoventral spurs in the latter. The distal part of the peritreme is not of diagnostic value, because it is hooked in the *Mcgregorellus* section and straight or hooked in the *Pratensellus* section. The former are collected on dicotyledons, the latter generally live on monocotyledons (*Oligonychus bessardi* Guiterrez live also on Gramineae: *Isachne mauritiana* and *Acrocerus* sp.). Considering the additional information on karyotypes, both groups are probably worthy of subgeneric status.

Four species of the subgenus *Oligonychus s.str.* have 2n = 6, whereas *Oligonychus punicae* (Hirst) has 2n = 4. This subgenus is probably heterogeneous, but the number of species studied is insufficient for an appropriate discussion.

The diploid number of 2n = 6, in *Oligonychus thelytokus* Gutierrez strengthens the established relation with *Oligonychus coffeae* (Nietner), even though the male of the first species is unknown.

The 17 examined *Tetranychus* species (Table II), belong to the three subgenera defined by Tuttle and Baker (1968): *Polynychus* Wainstein, *Tetranychus* Dufour *s.str.* and *Armenychus* Wainstein.

The 3 species of the subgenus *Polynychus* all have 2n = 8. It is remarkable

TABLE II.
Chromosome Numbers in 17 Different Species of the Genus *Tetranychus* Dufour.
((P.) = Subgenus *Polynychus* Wainstein; (T.) = Subgenus *Tetranychus* Dufour *Sensu Stricto;* (A.) = Subgenus *Armenychus* Wainstein).

Species	Geographic Origin of the Strain	Host Plant	Number of Chromosomes	
			2n	n
Tetranychus (P.) panici Gut.	Madagascar	*Panicum uvulatum*	8	4
T. (P.) roseus Gut.	Madagascar	*Medemia nobilis*	8	4
T. (P.) tchadi Gut. and Boll.	Tchad	*Dolichos lablab*	8	4
T. (T.) marianae McGregor[a]	N. Caledonia	*Hibiscus* sp.	8	4
T. (T.) tumidus Banks	U.S.A.—Louisiana	*Gossypium hirsutum*	12	6
T. (T.) hydrangeae P. and B.	The Netherlands	*Hydrangea* sp.	6	3
T. (T.) kaliphorae Gut.	Madagascar	*Kaliphora madagascariensis*	6	3
T. (T.) lambi P. and B.[a]	N. Caledonia	*Manihot utilissima*	6	3
T. (T.) lombardinii B. and P.[a]	Kenya	*Iresine herbstii*	6	3
T. (T.) ludeni Zacher	Madagascar	*Thunbergia alata*	6	3
T. (T.) macfarlanei B. and P.[a]	Mauritius	*Hibiscus esculentus*	6	3
T. (T.) neocaledonicus Andre	U.S.A.—Louisana	Unknown	6	3
T. (T.) piercei McGregor[a]	Indonesia-Java	*Polygala paniculata*	6	3
T. (T.) turkestani (Ugar. and Nik.)	Yugoslavia	*Humulus lupulus*	6	3
T. (T.) urticae Koch	The Netherlands	*Sambucus nigra*	6	3
T. (A.) pacificus McGregor	U.S.A.—California	*Medicago* sp.	6	3
T. (A.) viennensis Zacher	The Netherlands	*Prunus avium*	6	3

[a] New record.

to notice that these three *Tetranychus* species have a very clear morphological affinity with mites of the genus *Oligonychus* of the *Pratensellus* section. In addition, the association with monocotyledons also seems characteristic for this subgenus.

With the exception of *T. marinanae* McGregor, the karyotypes of the subgenus *Tetranychus s.str.* are rather homogeneous. The diploid number 2n = 8 for *T. marianae* possibly indicates that this species has to be separated from this subgenus. *T. marianae,* however, is very different from the *Polynychus* species. It is tempting to consider the 2n = 12 of *T. tumidus* as a polyploid; the large size of *T. tumidus,* as compared to other *Tetranychus* species examined, is also suggestive in this connection.

POLYPLOIDY

In contrast to the higher plants, in which many species are polyploids or have been derived from polyploidy, this kind of speciation mechanism rarely seems to occur in the animal kingdom. The apparent barrier to polyploidy is the prevalence of fertilization in gonochoristic animals. A mutant tetraploid individual will find only diploid mates and, in the case that there is a successful mating, will leave only sterile triploid offspring.

The bisexual Tetranychidae might be able to bypass this kind of obstacle: a mutant tetraploid female can mate eventually with her partheno-produced sons, which will be of the appropriate genotypic constitution. In the laboratory, the efficacy of mother-son mating (in fact a delayed self-fertilization) has been demonstrated with *T. urticae* by van Zon & Overmeer (1972) in order to establish the fixation of chromosome mutations in separate strains. It is a mating procedure which might very well occur in nature under special conditions; the fact that in many species unfertilized females have an extended life period (cf. Gutierrez, 1967) will favor the opportunity for the success of a mother-son mating. If polyploidy is accompanied by an instantaneous barrier (for instance a mechanical one by an increase in size), mating with partheno-produced offspring will be highly probable (under the assumption that the diploid offspring are functional males). It is an unfortunate situation that the chromosome numbers in Tetranychidae are low, and consequently the possible occurrence of polyploidy not conspicuous. There are reasons to consider the presence of polyploidy in the evolution of Tetranychidae. The species with $2n = 12$ in the genus *Tetranychus* have already been mentioned. In the genus *Schizotetranychus,* the species *S. reticulatus* Baker and Pritchard, *S. schizopus* (Zacher) and *S. tephrosiae* Gutierrez have $2n = 6$, while *S. australis* Gutierrez has $2n = 12$. Also in other taxa, for instance in the Bryobiinae, the numbers give rise to the assumption that polyploidy is a speciation mechanism in Tetranychidae. Evidence, however, is difficult to obtain. Measurements of DNA-contents and allozyme-analysis of species with $2n = 12$ may provide information with regard to this subject.

SUMMARY

For nearly 80 species of Tetranychidae karyotypes have been determined. It is substantiated that karyotype information is of significance for the systematics of the Tetranychidae. With respect to the genus *Oligonychus,* from which the chromosome numbers of 18 species are determined, it is suggested that systematists examine the *Mcgregorellus-* and *Pratensellus*-sections for possible elevation to subgeneric rank. The supposed relationship between the *Pratensellus*-section of *Oligonychus* and the subgenus *Polynychus* of the genus *Tetranychus* is supported by karyotype analysis. The occurrence of polyploidy as a speciation mechanism in Tetranychidae is discussed.

REFERENCES

Gutierrez, J. (1967). *Coton et Fibres Tropicales* 22, 183-195.

Gutierrez, J. (1977). *ORSTOM, ser. Biol.* 12, 65-72.

Gutierrez, J. and Bolland, H. R. (1973a). *Ent. Berich., Amsterdam* 33, 54-60.

Gutierrez, J and Bolland, H. R. (1973b). *Ent. Berich., Amsterdam* 33, 155-158.

Gutierrez, J. and Helle, W. (1971). *Ent. Berich., Amsterdam* 31, 45-60.

Gutierrez, J, Helle, W., and Bolland, H. R. (1970). *Acarologia* 12, 732-751.

Helle, W. and Bolland, H. R. (1967). *Genetica* 38, 43-53.

Helle, W. and Bolland, H. R. (1972). *Entomol. Exp. Appl.* 15, 395-396.

Helle, W., Gutierrez, J., and Bolland, H. R. (1970). *Genetica* 41, 21-32.

Helle, W., Bolland, H.R. and Gutierrez, J. (1972). *Experientia* 21, 707.

Oliver, J. H. (1977). *Ann. Rev. Ent.*, 22, 407-429.

Pijnacker, L. P. and Ferwerda, M. A. (1972). *Experientia* 28, 354.

Pijnacker, L. P. and Ferwerda, M. A. (1975). *Experientia* 31, 421-422.

Pijnacker, L. P. and Ferwerda, M. A. (1976). *Experientia* 32, 158-160.

Pritchard, A. E. and Baker, E. W. (1955). *Pac. Coast. Entomol. Soc.* Mem. 2, 1-472.

Tuttle, D. M. and Baker, E. W. (1968). "Spider Mites of Southwestern United States and a Revision of the family Tetranychidae." Univ. Arizona press, 1-143.

Wainstein, B. A. (1960). *Trud. Nauk. Issled., Inst. Zash. Rast.* 5, 1-276.

Zon, A. Q. van, and Overmeer, W. P. J. (1972). *Entomol. Exp. Appl.* 15, 195-202.