

RESEARCH PAPER

Occurrence of polyploidy in the weevil *Odoiporous longicollis* Olivier (Coleoptera : Curculionidae)

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ABSTRACT

The chromosomes of female individuals of banana weevil, *Odoiporous longicollis* Olivier were investigated and polyploid chromosome counts were observed in the female specimens. Tetraploid and hexaploid parthenogenetic races ($4x=52$ and $6x=78$) were observed for the first time in Jammu Region. The species has a diploid bisexual race as well having $2n=26$ chromosomes. Since the coexistence of diploid and polyploid members within the same population is a rather rare event in the different species of curculionids, the mechanism of origin of polyploid individuals is discussed.

Key words : Polyploidy, Oogonial, Bisexual, Parthenogenetic, Apomictic

Sexual reproduction is the predominant genetic system in eukaryotes whereas parthenogenesis is an alternative genetic system where all individuals are females and inheritance is typically clonal (Maynard Smith, 1978). Organisms that reproduce by parthenogenesis offer many potential insights into cytology, genetics, ecology and evolution. Among insects, the weevils are well known for having a large number of polyploid lineages (Suomalainen *et al.*, 1987). Among parthenogenetic weevils, there are two diploids, 48 triploids, 18 tetraploids, six pentaploids, three hexaploids and one decaploid races have been observed (Lachowska *et al.*, 2008). Parthenogenetic weevils are apomictic *i.e.* they lack meiosis and recombination. Among more than 600 species of curculionid weevils that have been studied cytologically (Lachowska *et al.*, 2006), 70 species or races belonging to the five subfamilies *viz.* Otiorrhynchinae, Brachyderinae, Eremninae, Leptopinae and Cylindrorrhynchinae are parthenogenetic (apomictic or thelytokus) (Takenouchi, 1982). *Odoiporous longicollis* belongs to family Curculionidae and subfamily Rhynchophorinae represented by 20 species. Chromosome counts showing higher levels of ploidy were observed for the first time in the female species investigated though no Indian curculionid species was previously reported to be polyploid (Gill, 1974). A cytological survey of this species showed the coexistence of individuals with a diploid bisexual race as well as polyploid races. (Takenouchi, 1965) reported parthenogenetic type of reproduction in *Trachypholeus bifoveolatus*, *Mylocerus fumosus* and *Macrocorynus*

griseoides (Takenouchi, 1981a); *Myosides pyrus* (Takenouchi, 1981b); *Scepticus insularis* Roelofs (Takenouchi, 1968, 1982); *Catapionus gracilicornis* Roelofs (Takenouchi, 1966); *Mylocerus nipponicus* (Takenouchi, 1972a); *Myosides seriehispidus* and *Trachyrinus* sps. (Takenouchi, 1972b); *Sciaphilus asperatus* and *Tropiphorus terricola* (Takenouchi, 1965); *Callirhopalus bifasciatus* (Takenouchi, 1981b); *C. minimus* (Takenouchi, 1974, 1977); *C. setosus* (Takenouchi, 1974) and *C. obesus* (Takenouchi, 1976). *Listroderes costirostris* (Takenouchi, 1957, 1969) and *Lissorhoptrus oryzophilus* (Takenouchi, 1977) showed only parthenogenetic polyploid races while a few other species showed both bisexual as well as parthenogenetic races (Takenouchi, 1970). In the bisexual forms under the subfamilies, Otiorrhynchinae and Brachyderinae, this number ranges from 30 to 44. Variation in the chromosome number is very common in the parthenogenetic weevils. However, it is relatively unusual in the bisexual weevils. However, to elucidate the evolutionary events occurring within the genus studied during the present investigations, a more thorough analysis including electrophoretic, chromosomal and morphological data are necessary. This paper reports the normal chromosomal counts, polyploid counts and mechanism of origin of polyploid individuals.

MATERIALS AND METHODS

Adults of fifteen weevil species of *Odoiporous* were collected from *Musa paradisica*. Chromosome preparations were set up from gonadal tissues. Gonads dissected in hypotonic solution were treated hypotonically

in 0.5% KCl with 0.05% colchicine at room temperature for 30 minutes, fixed in freshly prepared fixative (methanol and acetic acid in the ratio of 3:1) for 30 minutes and proceeded for Air-Drying Giemsa Staining technique. Good images were photomicrographed using Nikon research microscope (1000X). Since we met some difficulties in obtaining a sufficient number of well spreaded metaphase plates in females, cytogenetical studies in these species were limited to the determination of chromosome number.

RESULTS AND DISCUSSION

Some females provided several oogonial metaphases in which a chromosome count was possible. The polyploid forms were characterized by the basic number of 13 chromosomes. The diploid count of 26 chromosomes (Fig. 1, 2, 3 and 4) were observed in the normal females which were in conformity with the occurrence of haploid number of 13 occurring in the subfamily Rhynchophorinae (Sharma

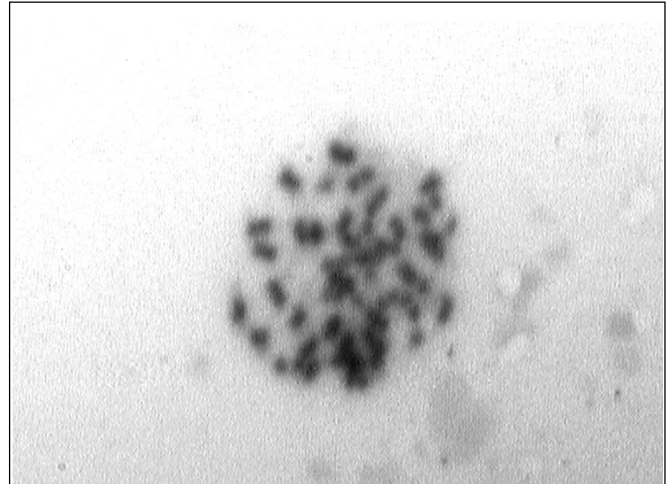


Fig. 3 : Oogonial chromosomes of *Odoiporous longicollis* showing 26 chromosomes

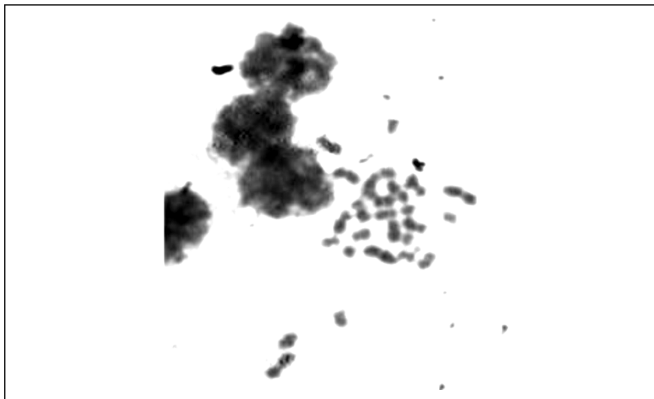


Fig. 1 : Oogonial chromosomes of *Odoiporous longicollis* showing 26 chromosomes

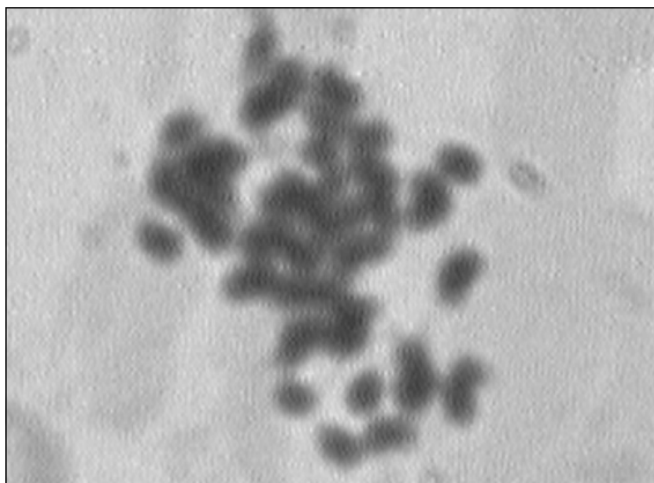


Fig. 2 : Oogonial chromosomes of *Odoiporous longicollis* showing 26 chromosomes

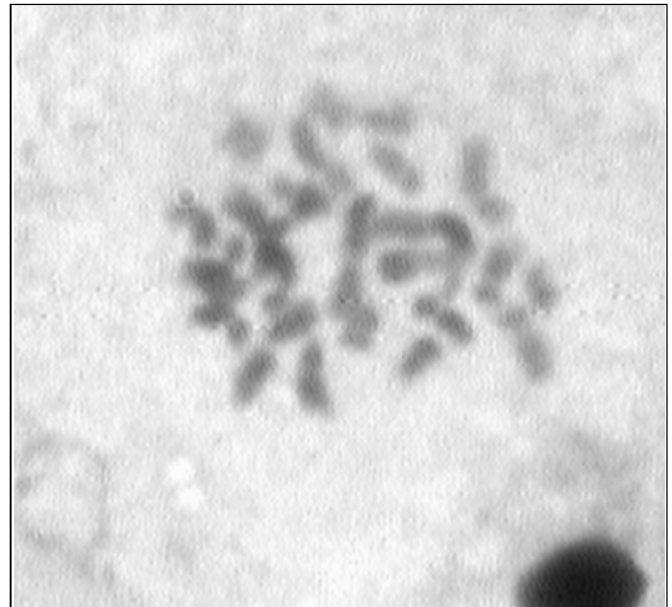


Fig. 4 : Oogonial chromosomes of *Odoiporous longicollis* showing 26 chromosomes

et al., 1980). The oogonial metaphase complements with 52 chromosomes (Fig. 5, 6 and 7) and 78 chromosomes (Fig. 8 and 9) were observed which were the exact multiples of basic number 13 occurring in the females of same species as observed. Several oogonial nuclei showed concentration of chromosomes undergoing spiralization and association forming rings (Fig. 12) crosses (Fig. 13 and 14) and clusters (Fig. 15) as in automictic diakinesis. The co-existence of a diploid bisexual race and its polyploid parthenogenetic counterpart as observed during the present study has been recorded in many weevil species

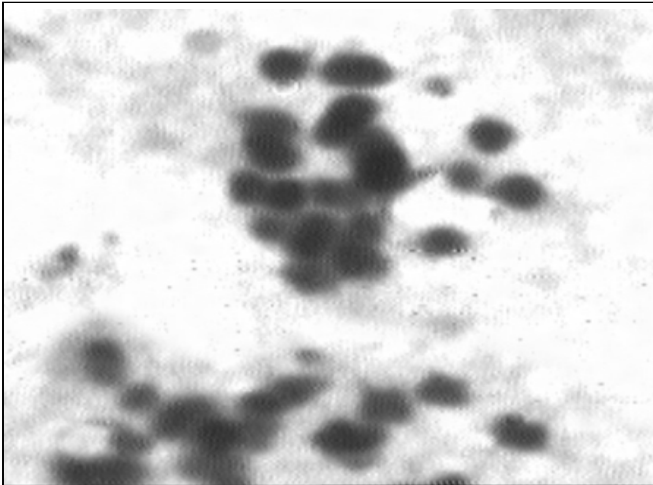


Fig. 5 : Oogonal chromosomes of *Odoiporus longicollis* showing 26 chromosomes

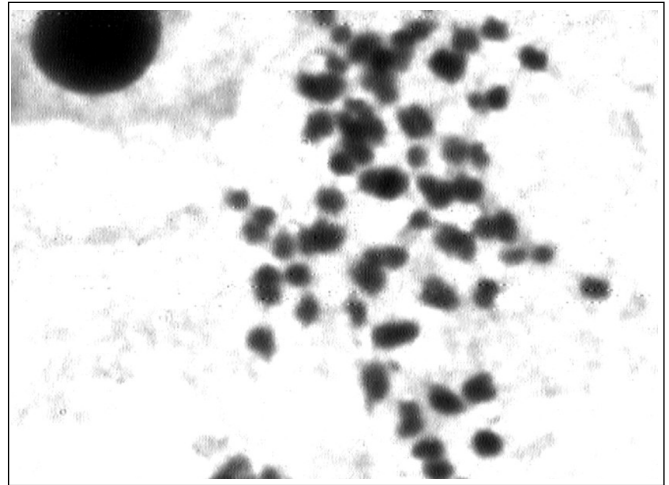


Fig. 8 : Oogonal chromosomes of *Odoiporus longicollis* showing 26 chromosomes



Fig. 6 : Oogonal chromosomes of *Odoiporus longicollis* showing 26 chromosomes



Fig. 9 : Oogonal chromosomes of *Odoiporus longicollis* showing 26 chromosomes



Fig. 7 : Oogonal chromosomes of *Odoiporus longicollis* showing 26 chromosomes

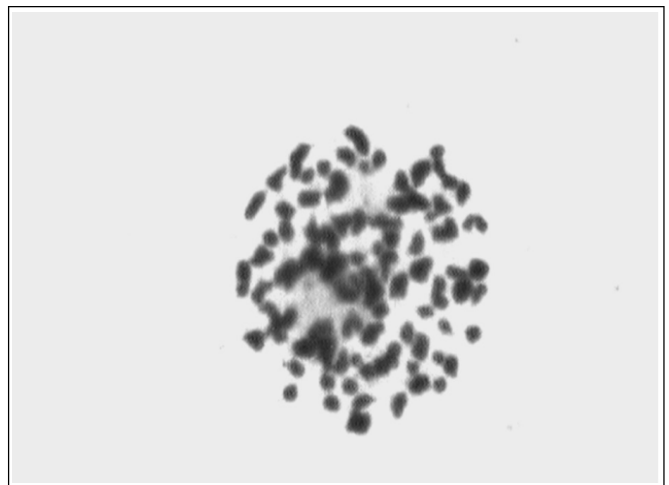


Fig. 10 : Oogonal chromosomes of *Odoiporus longicollis* showing 26 chromosomes

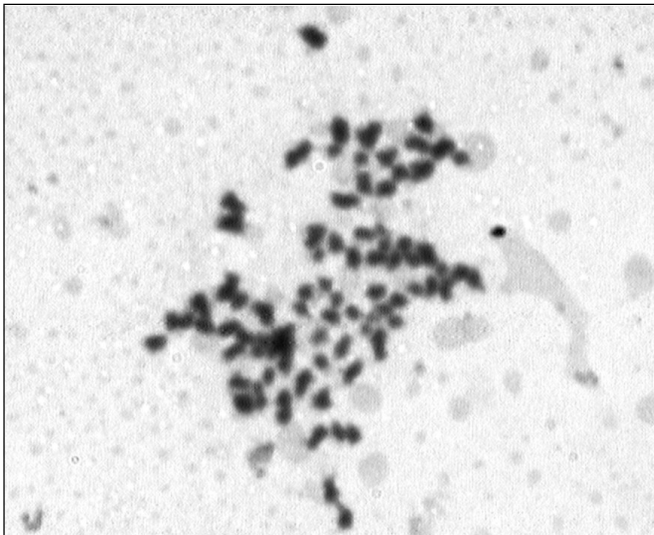


Fig. 11 : Oogonal chromosomes of *Odoiporous longicollis* showing 26 chromosomes

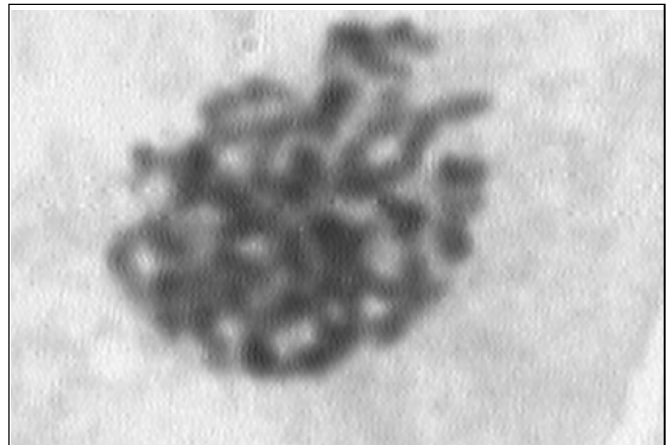


Fig. 14 : Oogonal chromosomes of *Odoiporous longicollis* showing 26 chromosomes

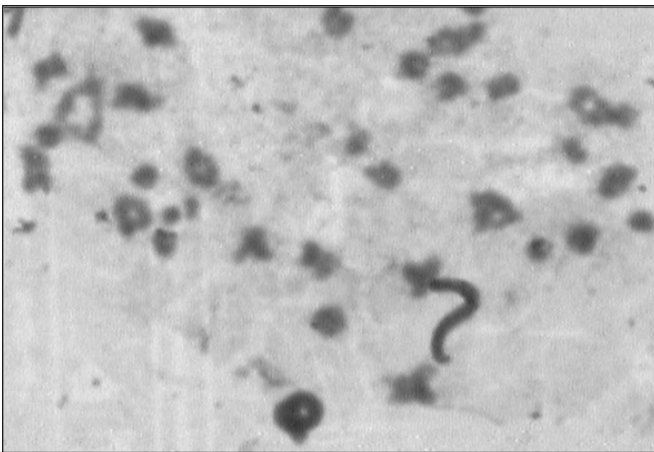


Fig. 12 : Oogonal chromosomes of *Odoiporous longicollis* showing 26 chromosomes

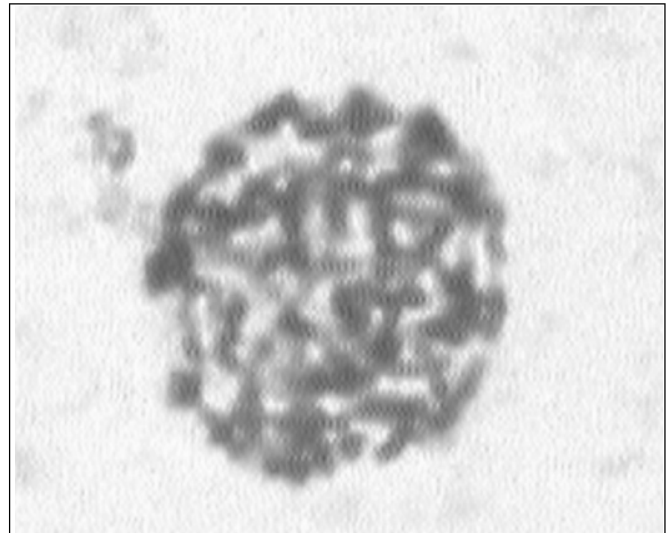


Fig. 15 : Oogonal chromosomes of *Odoiporous longicollis* showing 26 chromosomes

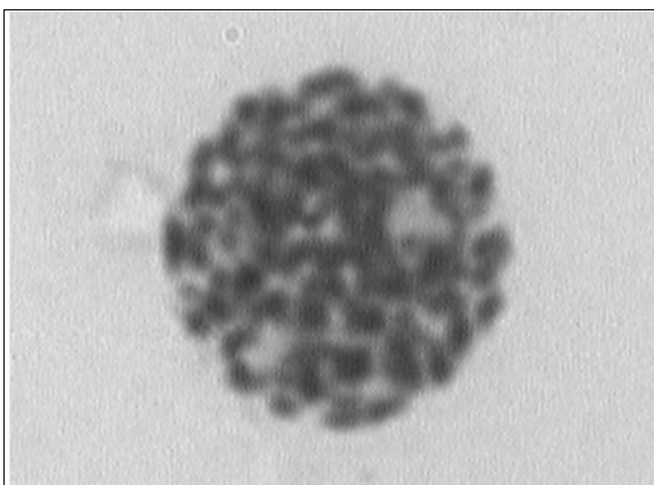


Fig. 13 : Oogonal chromosomes of *Odoiporous longicollis* showing crosses

eg. (Suomalainen, 1966). *Otiorrhynchus* species are exclusively diploid but all parthenogenetic *Otiorrhynchus* weevil species studied so far are polyploid. According to (Tucic and Mesaros, 1992), no one diploid parthenogenetic *Otiorrhynchus* species was found. Among the parthenogenetic weevils, the parthenogenesis is exclusively connected with polyploidy. It has been suggested by several authors that the parthenogenetic insect races originate from the diploid bisexual ones (Seiler 1943, 1961; Seiler and Schaffer, 1960; Suomalainen *et al.*, 1973). So diploid bisexual races become at first parthenogenetic diploid and after that develop into a polyploid parthenogenetic one. According to (Suomalainen *et al.*, 1973) the development of the different weevil races could be explained by assuming that the bisexual race

could hybridize with the parthenogenetic race. Since there is no reduction in the number of chromosomes in the eggs of parthenogenetic weevils, a hybridization of this kind would lead to the formation of a triploid race if the parental forms were a bisexual and a diploid parthenogenetic race. In our results, we have found coexisting the diploid females and polyploid individuals. Although we were not able to discriminate between the diploid females and the parthenogenetic ones, it seems reasonable to suppose that parthenogenetic tetraploid females could arise by hybridization of female triploids and sexual male individuals. The chromosome number in polyploid parthenogenetic weevils whether in the oogonial and maturation metaphases of a specimen or a species, may not always be an exact multiple of the basic number. This phenomenon is quite common in the polyploid parthenogenetic weevils studied so far (Takenouchi, 1978). There is the occurrence of several parthenogenetic species with two or three races of different degrees of polyploidy in addition to the diploid bisexual races. This phenomenon is called geographic parthenogenesis. One example is the European *Otiorynchus scaber* which has tetraploid, triploid and diploid bisexual races (Suomalainen *et al.*, 1987, Sternberg *et al.*, 2000). The coexistence of sexual and parthenogenetic lineages was proven by molecular analysis in *Aramigus pallidus*, in which parthenogenetic and bisexual forms were morphologically indistinguishable (Normark, 1996). *Blosyrus japonicus* is another species where both diploid bisexual and parthenogenetic races co-existed (Takenouchi, 1976). Our results also confirm these observations.

According to Takenouchi (1980, 1982), hexaploid curculionids arose from the triploid ones by a doubling of the chromosome number probably in the first cleavage division and octaploid animals from tetraploid and decaploid forms from pentaploids forms respectively. Even though polyploidy is in animals encountered in connection with parthenogenesis, a very high degree of polyploidy has been found in parthenogenetic animals only in the brine shrimp *Artemia salina* (Hass and Goldschmidt, 1946). All the parthenogenetic weevils so far studied cytologically are of an apomictic, thelytokus type in which eggs undergo one maturation division and chromosomes divide equationally so that no reduction takes place. Since polyploidy was reported for the first time during the present investigations, evolutionary divergence in individuals with diverse modes of reproduction and ploidy within the same population cannot be ascertained definitely unless weevil fauna widely distributed are cytologically surveyed and thus more

cytological work needs to be planned

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REFERENCES

- Gill, T. K.** (1974). Studies on the chromosomes of some of the Indian Curculionids. Ph.D. Thesis, Punjab University Chandigarh, India.
- Hass, G.** and Goldschmidt, E. (1946). A decaploid strain of *Artemia salina*. *Nature*, **158**:239-241.
- Lachowska, D.**, Rozek, M. and Holecova, M. (2006). Karyotypic characterization of three weevil species (Coleoptera: Curculionidae, Brachyderinae). *Folia Biol.*, (Krakow), **54**(1-2):13-17.
- Lachowska, D.**, Rozek, M. and Holecova, M. (2008). New data on the cytology of parthenogenetic weevils (Coleoptera, Curculionidae). *Genet.*, **134**: 235-242.
- Lachowska, D.**, Rozek, M. and Holecova, M. (2008). New data on the cytology of the parthenogenetic weevils (Coleoptera, Curculionidae). *Genet.*, (In Press).
- Maynard Smith, J.** (1978). *The evolution of sex*. Cambridge University Press, Cambridge.
- Normark, B.B.** (1996). Polyploidy of parthenogenetic *Aramigus tessellates* (Coleoptera:Curculionidae:naupactini): evidence from mitochondrial DNA sequences. *Evolution*, **50**:734-735.
- Seiler, J.** (1943). *Über den Ursprung der Parthenogenese and Polyploidie bei Schmetterlingen*. *Arch. JulliusKlaus-Stift.*, **18**:691-699.
- Seiler, J.** (1961). *Untersuchungen über die Entstehung der Parthenogenese bei Solenobia triquetrella F.N. (Lepodoptera, Psychidae). III. Die geographische Verbreitung der Rassen von Solenobia triquetrella (bisexual, diploid und tetraploid parthenogenetisch) in der Schweiz und in angrenzenden Ländern und die Beziehungen zur Eiszeit. Bemerkungen über Entstehung der Parthenogenese*. *Z. Vererbungsl.*, **94**:29-26.
- Seiler, J.** and Schaffer, K. (1960). Untersuchungen über Entstehung der Parthenogenese bei *Solenobia triquetrella* F.N. (Lepodoptera, Psychidae). *II Chromosoma*, **11**:29-102.

- Sharma, G. P.,** Gill, T. K. and Pal, V. (1980). Chromosomes in the Curculionid beetles (Coleoptera: Curculionidae). *The Coleopterists Bulletin*, **34**(4) : 361-367.
- Stenberg, P.,** Terhivuo, J., Lokki, J. and Saura, A. (2000). Clone diversity in the polyploid weevil *Otiorhynchus scaber*. *Hereditas*, **132** : 137-142.
- Suomalainen, E.** (1966). The first known case of polyploidy in a parthenogenetic curculionids, the native of America. *Hereditas*, **56**:213-221.
- Suomalainen, E.** (1969). Evolution in parthenogenetic Curculionidae. *Evol Biol.*, **3** : 261-296.
- Suomalainen, E.,** Saura, A. and Lokki, J. (1973). Evolution of parthenogenetic insects. In: *Evol. Biol.* (M. Hecht, W. Steere and B. Wallace, eds.), **9**: pp. 209-257, Plenum Press, New York and London.
- Suomalainen, E.,** Saura, A. and Lokki, J. (1987). *Cytology and Evolution in Parthenogenesis*. CRC Press, Boca Raton, Florida.
- Takenouchi, Y.** (1957). Polyploidy in some parthenogenetic weevils (A preliminary note). *Annot. Zool. Japan*, **30**(1):38-41.
- Takenouchi, Y.** (1965). Chromosome survey in thirty-four species of bisexual and parthenogenetic weevils of Canada. *Canadian J. Genet. Cytol.*, **7**(4) : 663-687.
- Takenouchi, Y.** (1966). Tetraploid and Pentaploid races of the Japanese parthenogenetic weevil *Catapionus gracilicornis* Roelofs (Curculionidae: Coleoptera). *Annot. Zool. Japan*, **39**:47-54.
- Takenouchi, Y.** (1968). A chromosome study on bisexual and parthenogenetic races of *Scepticus insularis* Roelofs (Curculionidae: Coleoptera). *Japanese J. Genet.*, **43**(5): 377-382.
- Takenouchi, Y.** (1969). A further study on the chromosomes of the parthenogenetic weevil, *Listroderes costirostris* Sch. *Cytologia*, **34**(3): 360-368.
- Takenouchi, Y.** (1970). A further chromosome study in bisexual and parthenogenetic races of the weevil, *Catapionus gracilicornis* Roelofs (Curculionidae: Coleoptera). *Japanese J. Genet.*, **45**(5): 457-466.
- Takenouchi, Y.** (1972a). A chromosome study of a new polyploidy weevil *Myllocerus nipponicus* Zumpt. (Coleoptera: Curculionidae). *Kontyu*, **40**(2):121-123.
- Takenouchi, Y.** (1972b). A chromosome study on two new Japanese parthenogenetic weevils (Curculionidae: Coleoptera). *Japanese J. Genet.*, **47**(1):19-22.
- Takenouchi, Y.** (1974). A study on the chromosomes of thirty-four species of Japanese weevils (Coleoptera: Curculionidae). *Genet.*, **45** : 91-110.
- Takenouchi, Y.** (1976). On the chromosomes of parthenogenetic Curculionid weevils in Japan. *Proc. Japan. Acad.*, **52**:126-129.
- Takenouchi, Y.** (1977). A tripartite first metaphase plate found in a parthenogenetic weevil, *Callirhopalus minimus* (Coleoptera: Curculionidae). *J. Hokkaido Univ. Educ.*, **28**(1):1-2.
- Takenouchi, Y.** (1978). A chromosome study of the parthenogenetic rice water weevil, *Lissorhoptus oryzophilus* Kuschel (Coleoptera: Curculionidae) in Japan. *Experientia*, **34** : 444-445.
- Takenouchi, Y.** (1980). Experimental study on the evolution of parthenogenetic weevils (Coleoptera:Curculionidae). *J.Hokkaido Univ.Educ. Section II B*, **31**:1-12.
- Takenouchi, Y.** (1981a). A chromosome study on two new polyploidy parthenogenetic weevils in Kyushu, Japan. *Genet.*, **55**:137-139.
- Takenouchi, Y.** (1981b). A chromosome study on the new parthenogenetic weevils, *Myosides pyrus* Sharp. *J. Hokkaido Univ. Educ. Sect. IIB*, **31**(2):55-57.
- Takenouchi, Y.** (1982). A triploid race of the reportedly parthenogenetic Japanese weevil *Catapionus gracilicornis* Roelofs (Curculionidae: Coleoptera). *Japanese J.Genet.*, **57**: 185-187.
- Tucic, B.** and Mesaros, G. (1992). Chromosome counts in some high altitude *Otiorhynchus* Germ. Species from Yugoslavia. *Caryologia*, **45**(2):213-219.
- Wanat, M.** and Mokrzycki, T. (2005). A new checklist of the weevils of Poland (Coleoptera: Curculionoidea). *Genus*, **16** : 69-117.

