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ROLE OF HEROLD'S ORGAN IN *ORYCTES RHINOCEROS* (COLEOPTERA: SCARABAEIDAE)

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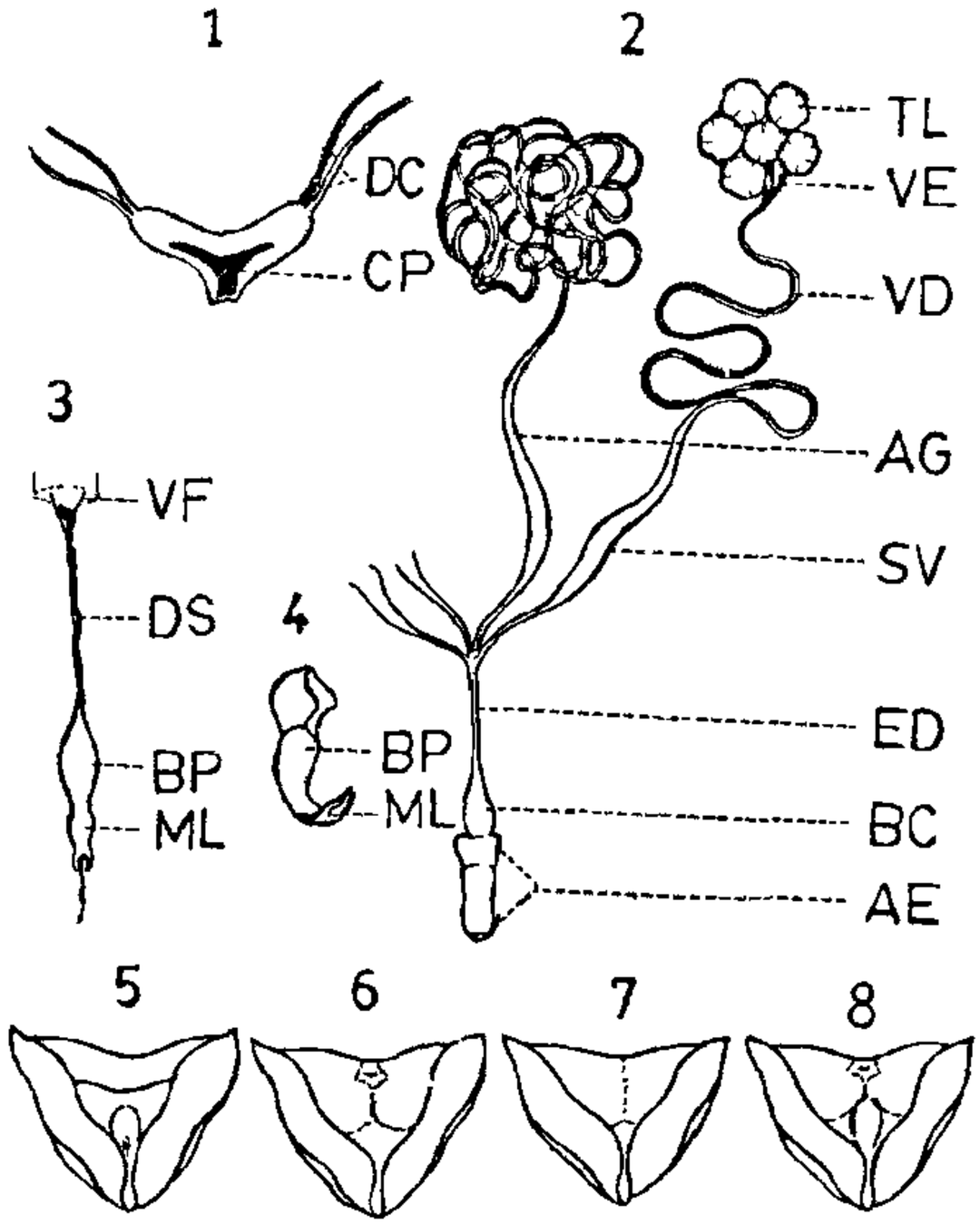
MALE larvae of *Oryctes rhinoceros* possess the organ of Herold (OH), visible externally through the cuticle on the venter of the ninth a[1] dominal segment[1, 2]. This paper reports the results of extirpation and implantation studies carried out with the purpose of understanding the significance of this organ in *O. rhinoceros*.

For extirpation, mature third instar larvae 90 days after the moult were held under a binocular dissection microscope without anaesthesia and an oblique cut was made close and parallel to one side of the organ using a sharp blade. The OH was then pulled out gently through this opening and detached from the cuticle using fine forceps.

The OH (figure 1) had a more or less triangular chitinous plate enclosed within a transparent bag-like structure with two antero-lateral arms, each with a pair of cords arising from it distally. As these cords are delicate, transparent, and resemble the tracheae, it was not possible to trace their entire path or ensure their complete removal.

For implantation studies, the OH thus extirpated was carefully implanted into female larvae of the same age through a small opening made ventrally on



Figures 1–8. Figures illustrating experiments involving extirpation and implantation of Organ of Herold in *Oryctes rhinoceros* larvae. **1,** OH from 90-day-old third instar male larva. **2,** Male reproductive system in normal adult. **3,** Male reproductive system developed from OH implanted in the female larva. **4,** Normal aedeagus, **5–8,** Genital area of pupae of; **5,** normal male; **6,** normal female; **7,** 'pseudofemale'; **8,** 'mixed-sex'. AE, aedeagus; AG, accessory gland; BC, bulbous chamber; BP, basal piece; CP, chitinous plate; DC, distal cord; DS, dry strand; ED, ejaculatory duct; ML, median lobe; SV, seminal vesicle; TL, testis lobe; VD, vas deferens; VE, vas efferens; VF, vaginal floor.

the ninth abdominal segment a little anterior to the centre, in the same position as in the male. For sham-operated controls, a small piece of larval cuticle was implanted instead of OH. No antibiotics were applied.

The operated larvae were kept singly in containers (13 × 6.5 cm dia) for two days till the wounds healed completely; they were left over cow dung, their food, till 20 days after adult emergence. Sham-operated and normal controls were also maintained similarly.

Secondary sexual characteristics of the pupae as well as of adults from OH-extirpated and OH-implanted larvae were examined.

Adults developed from normal and sham-operated

control larvae revealed fully developed reproductive system (figure 2) consisting of a pair of testes formed of six lobes each, giving out short narrow vasa efferentia. The six vasa efferentia from each side unite to form a long, coiled vas deferens, which continues posteriorly as a swollen duct, the seminal vesicle, which again narrows out before opening into the short median ejaculatory duct. From this junction arises a pair of accessory glands, each having a swollen basal part followed by a thinner duct, which is highly elongated and convoluted. The median ejaculatory duct is enlarged basally into a bulbous chamber before entering the chitinous aedeagus.

In adults developed from OH-extirpated larvae, the testes, vasa efferentia and only part of the vasa deferentia were found to have developed.

The majority of the OH-implanted female larvae (8 out of 10) did not show development of the implant. One of the implanted animals emerged as an adult female with a partially developed male genital organ hanging outside the body through the genital aperture. It showed a well-distinguishable but comparatively soft and hollow aedeagus with a straight median lobe ending in a bifurcated tip (figure 3), differing from the normal aedeagus (figure 4). The former had also a tubular basal piece, but the rest was represented by a thin and dried-up cord with a funnel-like distal end attached to the floor of the vagina. The opening of the vagina to the exterior was thus blocked. A similar strand of dried-up tissue projected out through the tip of the aedeagus. Clearly the OH from a 90-day-old third instar larva had the capacity to differentiate into part of the male reproductive system.

The OH-extirpated individuals were also found to exhibit marked individual variation with respect to the extent of development of their vasa deferentia. There appears to be a direct correlation between the length of vasa deferentia developed and the length of the distal cords extirpated along with the OH. In many lepidopterans solid cords of tissue extend from the testes to the OH distally[3]. Thus the vasa deferentia in *O. rhinoceros* seem to have a mesodermal origin, contrary to the reports of Muir[4] and Pruthi[5] in certain other coleopterans where an ectodermal origin is attributed to the whole of the efferent system, including the vasa deferentia. However, the findings in *O. rhinoceros* are in agreement with the findings in the coleopterans *Sitodrepa panicea*, *Gastroidea polygoni* and *Anthonomus pomorum*, in which the whole of the efferent system, except the vasa deferentia, is derived from an ectodermal invagination posterior to the ninth sternite, while the vasa deferentia are derived from the testes[6].

With regard to secondary sexual characteristics of the pupae[2], those from OH-extirpated larvae were found to have lost the characteristic male appearance. Instead they revealed a 'pseudofemale' appearance, with the ninth ventral abdominal segment divided into right and left lobes by a vertical cleft as in the female, the tenth segment being concealed by the tergum. The shining area with depression between the lobes, as found in females, was however absent.

Evidently it may be presumed that the abdominal secondary sexual characteristic of the male pupa is directly determined by the development of the external genital organs and that the female type is the basic type, developing in the absence of the male type. The result of implantation confirms this. The genital area of pupae from OH-implanted female larvae revealed a predominantly male character—in addition to the normal female characteristics, they also had a median elevated area, as in the male.

However, unlike in the pupa, the secondary sexual characteristics of the adult develop independently of the external genital organs. Thus beetles from OH-extirpated male larvae (or 'pseudofemale' pupae) still had the normal male secondary sexual characteristics (blunt and bare pugidium, as opposed to the conical and hairy one in the female) though the aedeagus was absent. Similarly beetles from OH-implanted female larvae (mixed-sex pupae) had the normal female secondary sexual characteristics in spite of the partially developed male external genitalia. Other sexually dimorphic characteristics, namely horn size[7] and size of the dorsal prothoracic depression (unpublished observation), were also normal in spite of the alterations in external genitalia. Certain sex-specific genetic or hormonal factors other than OH controlling adult sexual dimorphism are thus indicated.

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OCCURRENCE OF AUTOSOMAL MONOSOMIC FEMALE BLACK RAT FROM A RADIOACTIVE AREA—A CYTOGENETIC SPORT

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THE loss of one chromosome in the karyotype, i.e. $(2n-1)$ chromosomes or monosomy, is rare in animals, although it is known in natural plant populations[1-6]. Only a few cases of human autosomal monosomy have been reported[7,8]. We report a chromosome 9 monosomy in a female rat from a natural population.

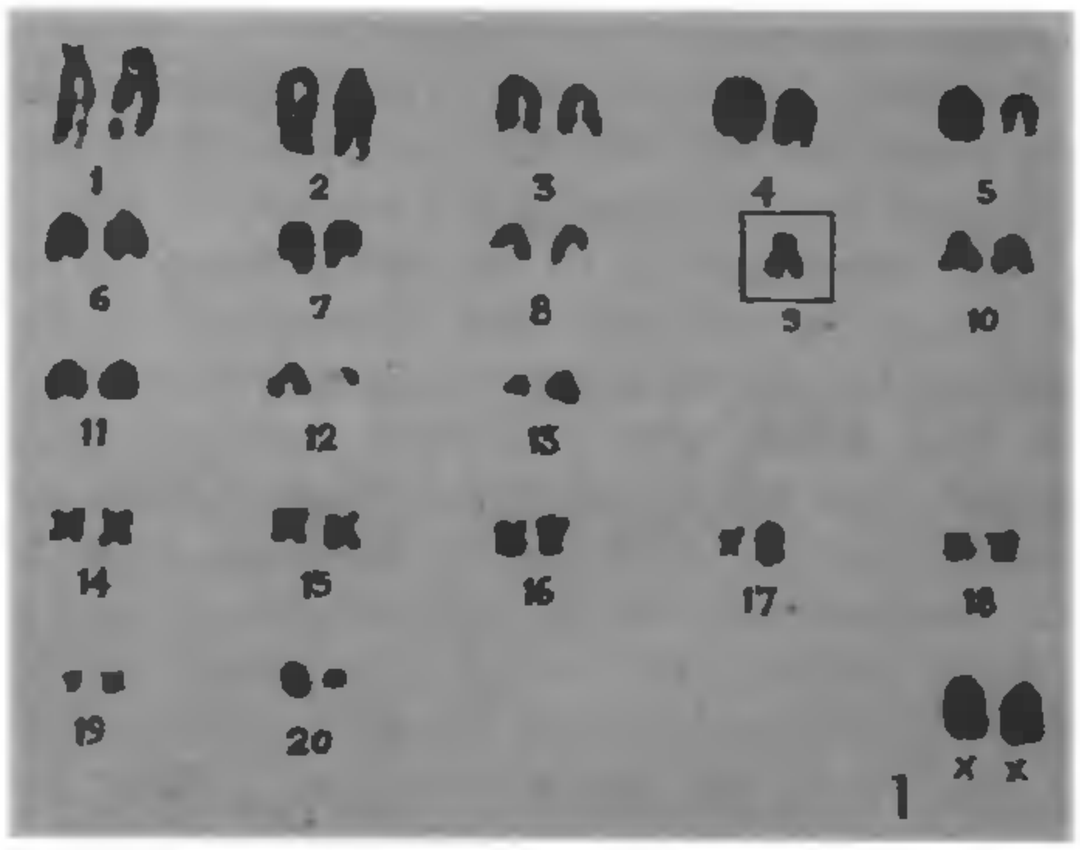
Seventysix black rats (*Rattus rattus*) were caught at random in Chhatrapur (19.21°N, 85.03°E), Ganjam district, which is situated on the coast of Orissa state and is known for its background radioactivity due to deposition of thorium-enriched monazite sands in the beach area. Chromosomes from bone marrow cells following the colchicine–citrate–Giemsa air drying technique[9] were prepared. Karyotypes were constructed from photomicrographs of well-spread metaphases[10].

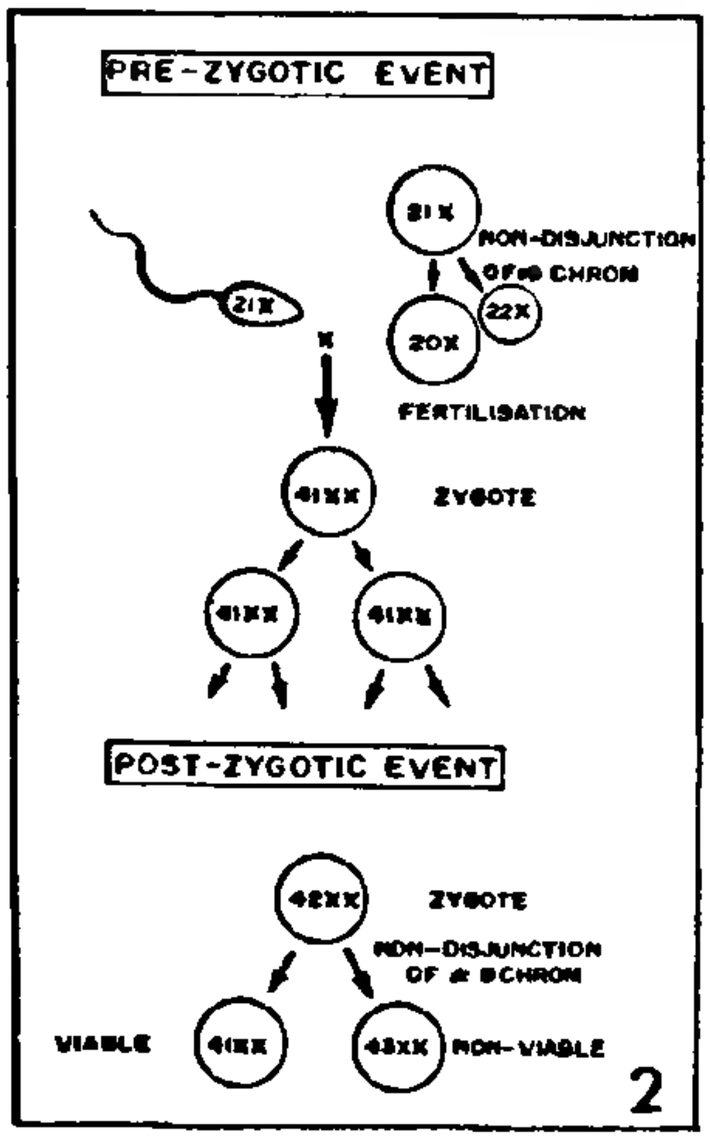
Of the 76 individuals studied cytogenetically, 46 were females and 30 were males. Seventyfive individuals had the usual diploid number of 42 chromosomes. Only one female (CHA ♀ 56) had 41 chromosomes (figure 1) in all the cells examined from the bone marrow. There was no visible abnormality in this individual, except for severe inflammation in the right side of the abdomen below the skin, which was suspected to be a solid tumour.

The normal karyotype of Chhatrapur rat includes 13 pairs of acrocentrics, 7 pairs of metacentrics, and acrocentric XX or XY chromosomes. Karyotype analysis of CHA ♀ 56 showed that one homologue of chromosome 9 was lost.

The human autosomal G monosomy is associated with many abnormal features described as antimongolism[11]. Monosomies 5 and 7 have been reported to be more frequent in acute non-lymphocytic leukaemia (ANLL), and monosomies 8 and 22 have been found to be associated with meningiomas[8]. The role of monosomy in initiating carcinogenesis is not yet clearly understood. But it has been suggested that genomic alterations may predispose some individuals to cancer[12]. In mammals, spermatocyte and oocyte aneuploidy may increase with age[13] and with exposure to temperature variations, radiation and chemicals[14-16].

The chromosome 9 monosomy detected in a





Figures 1 and 2. **1,** Karyotype of the female monosomic rat. **2,** Possible mechanisms for the origin of monosomic female rat (41, XX).