Experimental X-irradiation of pill bugs

by Kiyoshi Takewaki

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Information seulement
Experimental X-radiation of pill bugs

(Dangomushi-ni okeru X-sen shōsha jikken)

By Kiyoshi Tekewaki, Imperial University Tokyo, Zoology Department.


Among crustaceans, oostegites are the breeding characteristics of females seen in isopods and amphipods. Normally they are completely formed during the molt at the maturation time of the ovary, at the approach of spawning. However, if maturation of the ovary does not occur as a result of "parasitic castration", or due to radiation from radium, it is observed that the oostegite does not form completely despite repeated molts. From this it has been concluded that oostegite formation is controlled by hormones from the ovary coming close to maturity (Haemmerli-Boveri, 1920, water bug, Asellus; le Roux, 1937, beach hopper, Gammarus). However, it was clear to the authors, who observed in Armadillidium vulgare that when the ovary was excised well before breeding time, many oostegites appeared, so that their successful production was not related to the ovary (Takewaki & Nakamura, 1943, 1944).

On March 18, 1946, at the Imperial University of Tokyo, Professors Okada and Nakaizuma, with the aid of Assistant Professor Koso with Mr. Miyakawa's assistance, were granted the opportunity of conducting X-ray
experiments on pill bugs, at the radiation branch of the medical school dispensary. The results of observations on breeding of irradiated animals were in satisfactory agreement with the conclusions drawn from tests involving excision of the gonads. The general effect of radiation is herein reported, as well as observations with reference to sexual characteristics.

**Method**

The pill bugs were arranged, in a single layer on a 5 plates slide tray with sliding doors. A sheet of cellophane was attached to the top to prevent escape. This was put in a vertical position and propped up so as to provide an all around X-radiation. The radiation parameters were: tube voltage - 180 kV; unfiltered; current in X-ray tube 5 mA; distance between focus and specimens - 31 cm.; dose was 75r/min. The No. 1 group (female) was irradiated for 50 min. (3750 r); Nos. 2 and 3 groups (female and male respectively) 100 min. (7500 r). The irradiated animals were bred and continuously observed in a Petri dish, 8 cm. diameter, 1-2 in each, starting the next day. The method of breeding was in accordance with that reported by Takewaki and Nakamura (1944). The numbers of animals irradiated were; group No. 1 - 91, No. 2 - 86, No. 3 - 113. Observations and comparisons were made on 60 controls (47 females, 13 males), for which breeding began at the same time as the specially irradiated animals.

**Results**

1. **Mortality** Apart from those fixed to provide for histological investigation, there were 80 in group No. 1, 71 in No. 2, 99 in No. 3. Of these, relatively few in each group died within 2 months of radiation; viz: 3 in group No. 1 (3.9%), 2 in No. 2 (4.2%), 1 in No. 3 (1%) and none in the control group of 60. However, within 3 months 60 (75%), 39 (54.5%), 41
(41.4%) and 3 (5.0%) respectively and within 4 months, 80 (100%), 67
(94.4%), 51 (51.5%) and 3 (5.0%) were dead. It was thus found that the
mortality of irradiated animals, especially among females, was high.

2. Molting At least 89 (98.9%) of the specimens in group No. 1, 58
(67.4%) in group No. 2, 37 (32.7%) in group No. 3 underwent one molt
after radiation; the rate was 60 (100%) for the control group. The data
are shown in Table 1.

<table>
<thead>
<tr>
<th>Group</th>
<th>Number</th>
<th>Molt in 30 days</th>
<th>Molt in 60 days</th>
<th>Molt in 90 days</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. 1</td>
<td>89</td>
<td>12 (13.5%)</td>
<td>83 (93.3%)</td>
<td>89 (100%)</td>
</tr>
<tr>
<td>No. 2</td>
<td>58</td>
<td>1 (1.7%)</td>
<td>33 (56.9%)</td>
<td>58 (100%)</td>
</tr>
<tr>
<td>Female controls</td>
<td>47</td>
<td>7 (14.9%)</td>
<td>47 (100%)</td>
<td></td>
</tr>
<tr>
<td>No. 3</td>
<td>37</td>
<td>0</td>
<td>14 (37.8%)</td>
<td>37 (100%)</td>
</tr>
<tr>
<td>Male controls</td>
<td>13</td>
<td>7 (53.8%)</td>
<td>13 (100%)</td>
<td></td>
</tr>
</tbody>
</table>

Thus it was found that molting of irradiated animals is either
suppressed or delayed and this was specially noticeable when the radia-
tion dose was large. Also the effect was far more striking in males than
in females. In conclusion it was thought that delay or suppression of
molting was nothing more than the result of injury to the integument due
to radiation, although examples of formation of reasonable folds in the
course of molting were not rare, especially with males. The fact that
there were few individuals that died without successfully completing molting once started, would seem to confirm this.
Table 2

<table>
<thead>
<tr>
<th></th>
<th>No. 1 molt</th>
<th>No. 2 molt</th>
<th>No. 3 molt</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oostegites formed</td>
<td>67 (75.3%)</td>
<td>2 (80.2%)</td>
<td>0</td>
</tr>
<tr>
<td>Oostegites not formed</td>
<td>22 (24.7%)</td>
<td>17</td>
<td>3</td>
</tr>
<tr>
<td>Dead</td>
<td>0</td>
<td>3</td>
<td>16¹)</td>
</tr>
</tbody>
</table>

¹) includes 3 fixed after second molt.

Table 3

<table>
<thead>
<tr>
<th></th>
<th>No. 1 molt</th>
<th>No. 2 molt</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oostegites formed</td>
<td>35 (60.3%)</td>
<td>0</td>
</tr>
<tr>
<td>Oostegites not formed</td>
<td>29 (39.7%)</td>
<td>3</td>
</tr>
<tr>
<td>Dead</td>
<td>0</td>
<td>28¹)</td>
</tr>
</tbody>
</table>

¹) including 1 fixed after first molt.

3. **Oostegite formation** The condition of oostegites in groups No. 1 and 2 is shown in Tables 2 and 3. Individuals were observed and compared only in the first molt.

As shown in the above tables, oostegites were formed in a number of irradiated animals, but in all examples they were incomplete, and did not reach the median line of the body. In the extreme case only irregularly shaped flat processes were attached to the base of the perisepods but no brood sac was successfully formed in any case. On the other hand, four
nipple-form processes (cotyledons) arose at the median line of the thoraco-ventral region and generally developed normally. These originally resided in the brood sac and, their epidermis was extremely thin and the derm was quite thick, and it could be thought that they seemed to release some secretions into the brood sac; but since the oostegites were incompletely formed they were exposed completely. Moreover since they were constantly covered with moisture, this became a main reason for fungus to tend to grow on the thoraco-ventral region and it was thought that this could be a big factor in adding to the mortality of irradiated females.

In the first group, 7 of the 67 producing oostegites at the first molt were fixed*. In the second group 3 of the 35 forming oostegites at the first molt were fixed and not 1 of the 32 others was successful in reaching a second molt. Two in the first group which were successful in molting made no oostegites at the second molt. 41 (87.2%) of the 47 control animals formed complete oostegites in the first molt and all of the remaining 6 produced one at the second molt. From the above, it was seen that oostegites were formed with difficulty in irradiated animals, specially by those receiving large radiation doses.

4. Gonads and sex characteristics There were no noteworthy changes in the testicles among the samples we were able to investigate, nor did anomalies appear in the male sexual characteristics. There was a varying degree of injury of the ovaries; in some cases, there was a complete regression and the ova were completely missing; in others the cells of the walls of the ovary were fairly thickened and filled the cavity of the ovary; in some cases the specimens were almost normal and laid big eggs filled with vitellus grains. In 3 cases of the first group actual spawning was

*no more than two among the remaining 60 reached another molt.
observed. The eggs adhered for a while to the thoraco-ventral region and of course were soon lost because the brood sac was absent. Changes were not noted in the permanent sexual characteristics of females. In short not all the sexual characteristics nor the initiation of oostegites are related to the condition of the gonads, and it is clear that the ovary and oostegite rudiments are independently affected by radiation. Thus, when the dosage is large, both may be considerably inhibited at the same time. In pill bugs and beach hoppers this state of affairs would certainly be observed after radiation with radium. Degeneration or suppression of the ovary definitely does not inhibit the completion of oostegite formation. Further, the fatty tissue suddenly increases on excision of the gonads in the case of both male and female (Takewaki & Nakamura, 1944; Takewaki, 1944), yet no observable change occurred in the fatty tissue after exposure to X-irradiation.

References

Kiyoshi Takewaki, and Norio Nakamura, 1943, Dobutsujaku Zasshi, 55, 128