Observations on the Biology and the Ecology of *Oryctes agamemnon arabicus*, a Pest of Date Palm Tree in Southwest Tunisia

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ABSTRACT

Soltani, R. 2014. Observations on the biology and the ecology of *Oryctes agamemnon arabicus*, a pest of date palm tree in Southwest Tunisia. Tunisian Journal of Plant Protection 9: 131-142.

Oryctes agamemnon arabicus was an exogenous species accidentally introduced in the oases of Mrah Lahouar from Tozeur on 1980's and officially reported in southwest Tunisia on 1995. This pest closely associated to date palm was spread in some oases of southwest Tunisia, covering actually 3310 ha. The preferred development sites are standing living palm trees. Different parts of the plant are subject of the attack of this pest such as respiratory roots, external components of the stem and the oldest basal green palms of the crown. The attacked site contains often different stages of the cycle of the insect like mating, oviposition, larval feeding, pupation and adult emergence. In some cases, beetles are attracted to heap manure, when it exists inside oases, buried on the soil as compost. The life cycle of immature stages, from egg to adult emergence, under natural conditions still on average 319 days and is dominated by larval development which represent 89.6% of the total cycle. Consequently, larvae constituted the harmful stages of the species. Females prefer to deposit their eggs in friable material inside hidden sites of the palm tree. The mean registered fecundity of 43 females is 26.62 eggs/female. The female lies eggs separately leaving a space between each other and prefers to change the oviposition site often before finishing egg stock. The threat of *O. agamemnon arabicus* consists on the attack of respiratory roots. In fact, after many years of successive attacks of these roots by several generations, the larval tunnels interpenetrate and evolve on a large hole which weaken the basal support of the plant and lead to its sudden collapse by winds.

Keywords: Biology, date palm, ecology, life cycle, *Oryctes agamemnon arabicus*, southwest Tunisia

The genus *Oryctes* includes about 40 species. It belongs to Rhinoceros beetles group which constitute a group of medium to large-sized scarabs of the Dynastinae subfamily and whose males are distinguished by a large cephalic horn (5). Many species of this genus are associated with palm trees and cause severe damages to coconut, oil and date palms (1, 3).

Three *Oryctes* species develop specifically in date palms and are present in the Near- and Middle-East and in North Africa, namely *O. elegans*, *O. agamemnon* and *O. richteri*. The first two species are common throughout the Near- and Middle-East. They are univoltine, flying from spring to autumn (13). Though not reported as major pests, *O. elegans* and *O. agamemnon* inflict

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Accepted for publication 10 November 2014

chronic damage in date palm and cause economic losses in Iran and Iraq (10) contrary to *O. agamemnon* which has no direct effect on the production in Tunisia (16, 17).

Oryctes agamemnon arabicus is the representative species of the genus in some oases of southwest Tunisia (16). This pest was accidentally introduced in 1980's from the oases of the United Arab Emirates using offshoots as part of varietal exchange. It was reported for the first time in 1995 in the oases of Mrah Lahouar from Tozeur (11) and two years later in the oases of Rjim Maatoug from Kebili (16). During the first decade following its introduction, the species is acclimated to the oases conditions of Mrah Lahouar (380 ha) where it was spread by flight after the increase of its populations to infest palm trees of the existent variety Deglet Nour and their offshoots. Between 1980 and 1990, the lack of primary plant material, offshoots used in the extension of new plantations of Ibn Chabbatt, 10 km away, obligated farmers to use offshoots originating from Mrah Lahouar. By this way and due to the lack of awareness about this pest, *O. agamemnon arabicus* spread and covered about 800 ha. In this zone of Djerid, the species had acclimated to the new conditions and its population amplified considerably and reached a critical situation to date palm trees. Consequently, major palm trees and their offshoots were invaded with this pest (16). After 1987, the lack of offshoots to supply the new project of Rjim Maatoug (1610 ha) from Kebili region oriented the project operators to import offshoots from the oasis of Ibn Chabbatt to complete the plantation. Thus, the same scenario as in Ibn Chabbatt was reproduced. Other separated oases covering about 520 ha were also infested by this pest in the region of Tozeur. Therefore, the pest is actually spread to 3310 ha which represent 10.1% of the total area of date palm trees in Tunisia.

No study on the ecology of *O. agamemnon arabicus* is done in the oases of southwest Tunisia. So, to understand more the species behavior in its natural habitat, we undertook the study of its ecology and biology. The work was based on a laboratory breeding trials and a field monitoring using a light trap to catch adults and a meticulous survey of different stages on palm tree.

This paper reports the main aspects on the ecological life history of the beetle under the oasis conditions of southwest Tunisia. It describes few traits of the behavior, biology and life cycle of the pest, oviposition activity, larval development, pupation and adults' activities. Such information can help in the establishment of a management program and this by the knowledge of the species and the identification of the damaging and sensitive stages.

MATERIALS AND METHODS

Study site.

Sampling and monitoring were conducted during three years, from May 2004 to June 2007, in Rjim Maatoug oases (1610 ha) situated in Saharan climate of Tunisia. This site, localized on the southwest edge of Chott El Djerid, has an average rainfall lower than 100 mm/year, a mean temperature of 21°C with extremes of 55°C in the shade in summer and 7°C in winter. Oases characterized by a sandy soil type were planted from 1987 to 1995. They were continental and of modern type due to the regular space of 9 m × 9 m between palm trees. The surrounding area inside oases included mainly fodder cultures (lucerne).

Life cycle and oviposition.

All observations were made under natural conditions of temperature in the

oases of Rjim Maatoug in southwest Tunisia. Boxes were placed inside a cabin constructed with dry palms in the oasis of the Rjim Maatoug developmental Office (ODRM) station. Observations on oviposition, incubation, larval development, pupation, and adult feeding and mating were followed by field observation of adult behavior (flight, mating and feeding).

Breeding methods and study of the life cycle. One male and one female were paired together inside opaque plastic box (20 cm × 15 cm × 10 cm). Boxes were filled with rotted sawdust collected from natural breeding site of the species, palm tree, used as oviposition substrate. Several holes were made on the cover to permit the ventilation of the box.

For life history trait studies, the boxes were daily inspected. The boxes were emptied and cleaned; the substrate was checked for eggs which were carefully removed using a spoon and with the surrounded substrate to other small boxes (10 cm × 5 cm × 5 cm) filled with the same substrate used as incubator. Eggs laid on the same day were placed by group inside the same box and the date of oviposition was inscribed on the cover. Eggs placed on the top of the substrate were three quarter of volume buried in to facilitate their control and to minimize their manipulation. At hatching, new emerging larvae were kept a day inside the same box before being removed by a group of three to six, hatching on the same day, inside big boxes (20 cm × 15 cm × 10 cm), with the same breeding substrate. Such a substrate had previously been advocated by Soltani *et al*. (17) for rearing larvae of this pest. The larval food was changed every two to three weeks for young larvae of first and second stage and usually every ten days for the third larval stage. Boxes were checked daily for mortality, signs of moulting and feeding behavior of larvae. When feeding activity slowed down, larvae of third stage were removed to other boxes filled with the same substrate to observe the behavior of this stage. The duration of immature stages of *O. agamemnon arabicus* were determined under Rjim Maatoug conditions.

Fecundity. A batch of 43 couples of *O. agamemnon arabicus* were confined in plastic boxes of 3 liters filled with rotting sawdust collected from infested palm trees. These boxes were controlled every three days, the content was sieved and examined for eggs which were removed, counted and noted on the cover. At the end of the experiment, when female died, the total numbers of eggs registered on the cover were quantified. The calculated number represented the fecundity (F_i) of the relative female. The mean of fecundity ($\overline{F}$) was calculated using the following formula:

$$\overline{F} = \frac{\sum_{i=1}^{n} Fi}{n}$$

with F_i: Fecundity of each female, n: total number of female used in the experience (n = 43).

Adult feeding, dispersal and mating.

The observations and the gathering of beetles from palm trees were conducted along diurnal and nocturnal transects through plantations. These transects permitted the collection of fundamental information for understanding a part of the adults' behavior in natural environment. The respiratory roots part of each chosen palm tree was probed with a saw. If a beetle or a couple was present, it was removed, and then taken back to the breeding trials. The location of occupied burrow was described; also the number of present individuals and eggs was noted. This

procedure provided some information on feeding, mating, and oviposition behaviors which were supplemented by laboratory trials with beetle bred in the same substrate.

Other beetles were caught in light traps. This light trap, 1.8 m height, was composed by basal parallelepipedic iron support of 1.2 m, a funnel with parallelepipedic top and four exits on the base linked to 4 stamps by four PVC tubes, two crossed sheets of plexiglas of 60 cm side fixed to a wooden support which was inserted on the top of the funnel. As light source, a neon was attached on the center of the wooden support and linked to a switch always activated on the position On. The lamp works using a solar implant equipped with a timer to control the On/Off operations. All these components are connected together in the same order already cited using a system of cable.

At night, beetles attracted by light bump into the sheet of plexiglas, fell in the funnel and gets dispatched by the PVC tubes to the stamps. The trap is weekly controlled, the stamps are emptied, and the total of caught adults counted and separated by sex.

RESULTS

Life cycle.

The duration of the immature stages is summarized in Table 1. These estimations are based on observations made under the oases conditions of Rjim Maatoug, where the development of one generation from egg to adult emergence last at mean 318.6 ± 17.82 days. Although, *O. agamemnon arabicus* is an univoltin species in this region; there is usually an overlap of generation in the field with all stages of the new generation and the last stages (third larval stage and pupa) of the mother generation mainly recorded between August and the first half of September at the respiratory roots part.

Results shown in Table 1 revealed that all larval development of this pest lasted on average 285.08 days which represent 89.48% of the duration of the total cycle. Also, the developmental time of third larval stage was the longest and dominated both the larval and the total developmental cycle with 66.35 and 59.37%, respectively. These results demonstrated that larvae are the harmful stages of *O. agamemnon arabicus* and particularly the third stage.

Table 1. Immature stages of development of *Oryctes agamemnon arabicus* and their respective durations in Rjim Maatoug area

Stage	Number of studied individuals	Duration (day)	Mortality (%)
Egg	220	12.95 ± 2.18	23.18
L_1	169	35.24 ± 4.32	12.42
L_2	148	60.69 ± 38.69	8.11
L_3	136	189.15 ± 44.55	2.94
Pre-pupa	43	15.2 ± 1.8	-
Pupa	132	20.81 ± 2.6	17.42
Adult	109	-	-

Oviposition. After mating, almost any medium soft enough for female burrowing, yet firm enough to provide compacted structure, well protected, and offering favorable conditions to the development of all stages of the pest may

be chosen as oviposition site. In the oases of southwest Tunisia, preferred breeding sites for *O. agamemnon arabicus* are standing living date palm trees and heaps of compost when they exist. In fact, the female deposit eggs in different parts of the palm tree, respiratory roots part and external components of the stem (between matrixes of fibrilium), and in heaps of sheep manure buried in the soil (compost).

For palm trees receiving the attacks for the first time, next steps are registered before starting eggs' oviposition: i) the female burrowed many centimeters (5 to 10 cm) below the surface, ii) female chewed and transformed progressively a small part of this plant material to small particles and extracted the juice to feed, iii) then the female laid eggs between chewed particles and agglomerated them back using posterior legs. This action was repeated several times on the same place; eggs were laid many centimeters spaced, to obtain at the end of this operation a continuous serpentine tunnel of many centimeters length and containing eggs between particles. These steps were recorded between intact hairy roots and on matrixes of fibrilium located between interior surface of dry petiole and stem's bark.

The respiratory root of the plant can receive multiple attacks by several generations through the years. In fact, on respiratory roots of already infested trees, females prefer deposit their eggs on decomposed plant material issued from previous attacks. However, they start directly their oviposition activity without wasting time in the preparation of a tunnel. Thus, this behavior permits to female to produce more eggs which are scattered randomly many centimeters spaced inside the lodging. A female do not deposit all eggs in the same lodging but disperse them on several palm trees. Contrary to the observed behavior in respiratory roots part, female deposit eggs once a time in the space between dry petiole and the bark of stem and no repeated attacks are registered in high level of the external component of the stem. Hence, females show an ascendant behavior of oviposition activity and this lead to conclude that attacks throughout the stem are ascendant. It is important to mention that the matrixes of fibrilium surrounding a level of dry petioles is not completely invaded by the eggs of females but just some parts situated under certain dry petioles which number varied from 0-2 eggs in basal level situated on the top of respiratory roots part, 0-4 eggs in medium level and 0-6 eggs in the upper level situated just under the crown.

The pollinators or male palm trees represent a special case. In fact, repeated oviposition and young larval attacks are recorded on the first level of dry petiole situated just above the respiratory roots part. This phenomenon is mainly owing to the height extension of the respiratory roots under the dry petiole of the first level.

Larval development. The eggs hatch in 9 to 19 days; the hatchings consume the chorion to be liberated. The first stage, completely white with soft head capsule and mouth parts, stays immobile about 4-10 h until the end of their hardening process. Then, larvae start feeding either on the chewed plant material composing the tunnel previously constructed by female beetle or in particles of substrate of ancient attacks already decomposed. In soft logs of respiratory roots, larvae can disperse freely from the oviposition site within the attacked volume.

Development of the two first larval stages coming from eggs laid under

summer conditions, proceed rapidly, and the third stage may be achieved in 10-12 weeks, whereas development of larvae, hatching from eggs laid in September, was firstly slowed down by the unfavorable conditions of autumn and then blocked by winter conditions which lead to the rest of all larval activities and the entry to hibernation. Larvae and adults constitute the hibernation forms of the species. Analysis of hibernating larval population during winter season shows important dominance of the third larval stage, with a percentage of 85 to 88.5%, issued from summer oviposition and a few number of the second larval stage, 10.3 to 14.1%, from the short duration of autumn oviposition. Larvae of the first stage are also present (0.9 to 1.3%) but only during December, after that disappear from the nature to reappear in the end of next spring.

At the end of each larval stage, a deceleration on the feeding and displacement activities marks the preparation to moulting. This phase lasted less than two days with first and second stages. However, larva of third stage marked at the end of its development a progressive and continuous deceleration of both feeding and moving activities until their total stopping. Thus, larva does not molt but starts a non feeding pre-nymphal period, pseudo-stage, which lasts between 12 and 22 days. Immobile inside a cell constructed using the surrounding crumbly material or plant tissue at the extremity of the larva's feeding tunnel, movement of pre-nymph are limited to the pygidium contraction-retraction. These repeated movements reduce the humidity inside the cell and contribute to compress the crumbly materials making them more cemented and compacted. Larval development, which duration is 181-302 days, is achieved by the nymphal moulting.

Field observations showed that cannibalism phenomenon is unusual but it mainly occurred when larvae of the third stage encounter the pre-pupal and pupal stages. When developing in the same lodging, larvae of the third stage are spaced out and appear to ovoid the meeting of each other. Survey of this behavior under laboratory trials show that inside the small space of boxes, larvae live spaced out and ovoid meeting; cannibalism is usually observed when the breeding medium becomes limited in supply and when larvae of the third stage coexist with pre-pupa and pupa.

Pupation. The pupal stage (Table 1) is spent inside the same cell of pre-pupa and where pupa took a dorsal position on the substrate with opened elytra and legs stick to the body. Its movements are limited to the contraction-retraction of the abdominal part. The color changes progressively from creamy white at the moment of moulting to brown-yellowish. Legs are progressively moved away from the body. Prior to adult moulting, the head, the thorax and legs becomes harden with dark color.

Adult feeding, dispersal, mating and sex-ratio.

As most of the other scarab beetles, *O. agememnon arabicus* needs the hot summer temperatures to accomplish its diverse vital activities (feeding, flight, and reproduction). Moulting starts by the liberation of legs followed by head, thoracic parts and abdomen. At the end of moulting process, the body of new emerged adults is divided into two parts; both head and thorax are harden and darken but, the rest of the body (abdomen) and elytra are creamy white and soft. The newly emerged adult remains almost immobile inside its pupation cell for 13 to 17 days.

During this inactive period, called pre-oviposition period, mainly initiated processes are the exoskeleton darkens and hardens and the differentiation of internal organs as the digestive system and the genital organs (1).

When fully sclerotised and have undergone some maturing, adults are ready to start their activities (feeding, flight and reproduction). So, each beetle chews its way out the pupal cell, usually using the larval tunnel, to be released in nature and flies to other palm trees to feed or to search for a sexual partner.

The survey of adults' feeding activity shows that their main food was composed by juice extracted from attacked hairy roots of the respiratory part. In fact, this activity is recorded when they chews their way out or enter to mate or to lie eggs (females) in attacked parts of the palm tree. For example, they reduce fresh hairy roots filled with water in small particles which are pressed between mouth part to extract the contained juice. This operation permits the diminution of relative humidity of particles which are used to build a tunnel where the female lies its eggs. Dissection of 20 adults (12 females and 8 males) collected using the light traps does not show any solid material in their guts which are white in color. Also, the digestive system is not well developed and is narrow in volume compared to the genital organs. Consequently, beetles do not ingest solid plant material; thus, they have a liquid alimentary regime which is based on the extraction of juice that emerges from the infested parts of the palm tree.

Field works conducted in different oases of Tozeur (2003) and Rjim Maatoug (2004-2007) showed that adults are never recorded on the crown i.e., there are no records of feeding and oviposition activities of adults in different levels of green palms, but only damages induced by the third larval stage on matrixes fibrilium, superficial injuries on the petiole of green palms, and sometimes on stem bark.

In the laboratory, feeding activity was not observed with beetles reared inside boxes yet proved by the absence of solid or liquid excrements. Adults mate normally and can live for more than 50 days without feeding.

During the day, *O. agamemnon arabicus* still hidden in breeding places on the palm tree. The beetle starts flying at twilight and is rarely observed out of the tree. During night surveys performed in the previous cited oases, most of flight activity occurred during the first half of night and appears to be limited to a few ten meters because of the abundance of breeding and mating sites (palm trees) and the heavy flight of adults imposed by their massive form; beetles are rarely even never observed on the ground and walk, as mean of dispersion, is limited to the same palm tree when the beetle passes or climbs from respiratory roots to the upper levels of dry petioles or between different levels of dry petioles.

The period of flight of the beetle take place between June and October. The total trapping of three years is 672 males and 1203 females. This sex-ratio is almost of 1:2 for females, this let suppose that females beetles apparently make more flights during the dispersal period to search a partner for mating or to search new breeding sites for egg deposition. Females taken from the trap and dissected contained full-sized eggs.

Flight activity is limited inside the same plantation or between border plantations of the same site because of the abundance of breeding sites. However, when adverse conditions occurred, the beetle can develop a behavior of flight for long distance between neighboring sites.

In the natural environment, the formation of couples and mating occurred in hidden attacked parts of the palm tree and never on the ground or on exterior parts of the tree. Night survey of beetles' activities showed that one to three females groups were found in the same mating place with one male. This phenomenon usually observed in the oases let suppose that females are aggregated together to facilitate the attraction of males using the additive actions of their pheromones. Couples are always located in the respiratory roots part and never observed between the fibrilium's matrixes between dry petiole and stem bark, inside the basal part of dry petiole and on different levels of the crown. However, in rearing trials, paired couples mated often inside the substrate and even if mating occurred on the surface of substrate, females burrow with the male on her back.

Based on the feeding behavior, females choose and prepare the site of mating between hairy roots then attract the male using their pheromone. One male can realize several matings with several females in the same mating site. Once copulated, female moves behind the site of mating, by chewing hairy roots, and many days later starts oviposition activity. In the same volume of respiratory roots, several females can coexist together.

Fecundity and fertility. Egg production or the fecundity per female ranged from 21 to 37 eggs with a calculated mean ($\overline{F}$) of 26.69 ± 6.21 eggs per female for the whole experiment. The mean duration of oviposition activity was 26.62 ± 6.16 days. The female reproductive success calculated for the all experiments was of about 76.82%.

Mortality and growth rate. Table 1 reveals that eggs and pupal stages represent the most sensitive stages of the species. The higher percentages of mortality are mainly caused by the decrease of temperatures at the end of the oviposition and pupation period in October. Between larval stages, the high rate of mortality was recorded with the first stage. This phenomenon is always observed at the beginning of the development. Larvae of the third stage are the most resilient and mortality is frequent at the end of this stage with pre-pupae which were subject to cannibalism.

Inside plantation, the registered cases of mortality are almost inexistent; but when they exist, they are caused by the decrease of temperatures (eggs and pupae in late September and in October) or cannibalism (prepupa and pupa). No cases of mortality induced by natural enemies were registered because of the absence of predators and parasitoids of this pest.

Damage.

The damage to date palms by *O. agamemnon arabicus* is caused only by larval stages. Inside the invaded parts of palm tree, larvae of the first and second stages start feeding either on crumbly material issued from previous attacks of the species (respiratory roots part) or on the tunnel prepared by female before starting oviposition (respiratory roots part and external components of stem). When larvae of these stages reach their full development, they can feed in hairy roots of small diameters (< 3 mm) in the respiratory roots part and on the superficial layers of fibrilium's matrixes. They dig tunnels between invaded tissues. However, voracious larvae of the third stage fed on all encountered plant material within the lodging and attacked deeply the layers of fibrilium, reached the

stem bark and bore into more solid wood where they excavate a cell. The real danger of the species consists on the repetitive attacks of the respiratory roots part. In fact, successive invasions by several generations through years lead to the overlapping and interpenetration of larval tunnels. In this case, the formation of a large hole on the base of the plant may be observed leading to weakening of its basal support and subsequent sudden collapse by wind. Consequently, respiratory roots part constitutes a zone of multiplication to the species and a threat to the survival of palm tree once invaded.

The attack of fibrilium's matrixes and dry petioles does not represent a danger to the plant because these are dead tissues with no vital functions. Thus, it can be considered as just a zone of multiplication to the species. There is no crop loss induced directly by the species because fruit bunches are not subjected to the attack of *O. agamemnon arabicus*.

DISCUSSION

To assure survival and development of the future descendants, females prefer deposit their eggs on living palm tree with a part of decaying material. This can partly explain the choice of the respiratory roots part and the ascendance of the attack throughout the stem. A similar behavior towards the choice of oviposition site was observed with other species belonging to the same genus (1). For *O. rhinoceros*, the most studied species of the genus. It has been found that the breeding sites of the beetle vary between countries. In fact, female prefers to lay eggs in rotting wood of dead standing coconut trees and cattle dung in Papua New Guinea, and in decaying trunks on the ground in Malaysia (3, 6, 7, 8, 14).

Fecundity per female announced for the same species (15) ranged from 17 to 22 eggs and was about 30 eggs (12). However, other authors reported a fecundity of 100 eggs per female (4). All the differences with present results can be due to the used biological material (the under-species), the development of immature stages (quality of food and length of the cycle), and to the experimental conditions. Important differences were recorded when compared with results of fecundity relative to *O. rhinoceros*. Indeed, the fecundity per female ranged from 30 to 40 eggs (18), or from 24 to 65 eggs with a mean of 51 ± 16 eggs (2) whereas other authors reported an average of 49 eggs (9) and a range of 70-140 eggs (8).

Results relative to the incubation period are similar to those cited in other reports; this period ranged between 10 and 16 days (12, 15). Compared to other *Oryctes* species, results are in agreement with those dealing with *O. rhinoceros* where the incubation of eggs lasted 11 days (7) or from 8 to12 days (2). About the larval development of *O. rhinoceros* in its Asian home land (from India to Indonesia) and on the South Pacific Islands, Hinckley (7) recorded a period of 77-105 days whereas Howard *et al*. (8) reported a duration period of 72-130 days. These results are totally different from our findings (181-302 days) mainly prolonged by the hibernation period which was absent for *O. rhinoceros* in its native home and may be by the quality and availability of foods.

The prepupal period lasted approximately 17.14 days for *O. agamemnon* (17) under laboratory conditions (23°C, RH: 55%) whereas a duration of 8-13 days was reported for the Scarabaeidae: Melolonthinae (1). It was also mentioned by Hinckley (7) and Bedford (3) for *O. rhinoceros* and was defined as a non feeding period starting after the construction of the pupal

chamber which lasts approximately one week. A duration of 20-29 days for nymphs was reported (12, 17) and these results are in agreement with the findings from to the present work and to other works conducted on *O. rhinoceros* species where the duration of this stage ranged between 21 days (7, 8) or from 17 to 28 days (18).

For *O. agamemnon arabicus*, a chosen site on the palm tree can be the site of mating, oviposition, larval feeding, pupation and adult emergence. However, the site contributes to the perpetuation of the population at one condition when the last stage, adult emergence, is achieved. These results agreed with those cited by Hinckley (7) for *O. rhinoceros* under the Western Samoa conditions.

Under natural conditions of Southwest Tunisia, the total life cycle of immature stages, from egg to adult emergence, lasted approximately 319 days. However, under favorable conditions of the same zone and from late spring (May) until mid-autumn, the same generation of *O. agamemnon arabicus* can develop in 22 to 25 weeks. This period of the year represents the appropriate period of the development of all stages of the species due to the favorable weather conditions, especially temperatures, and with no stopping period. Thus, feeding activity and growth rate are intense. At Keravat (Papua New Guinea), the total life cycle of immature stages *O. rhinoceros* lasts approximately 331 days (2), or about 7 to 8 months (9), or from 4 to 5 months, with the third stage occupying most of this period (2).

The pre-oviposition period is cited by Hinckley (7) and is called the teneral period; it lasts 3 weeks during which the exoskeleton darkens and hardens. A duration of 20-30 days was announced after ecdysis for this distinct pre-oviposition period (14) whereas Bedford (2) advanced that the feeding activity of adults belonging to *Oryctes* species is occasional and that beetles in this case can live without feeding during their life. Several authors agreed with the fact that the damage and crop loss induced by *O. rhinoceros* were only caused by the adult beetles. They fly to the palm crown of living trees and fed by burrowing galleries in the fresh tissues of palms' petioles which may result in breaking of the fronds during strong winds, digging into the stalks of fruit bunches. They cause damage to growing points and in that case the beetle kills the palm. In the tropical region, eggs and larvae of *Oryctes* species develop in the wood of dead trees: standing palms, dead coconut trunks and stumps, and decaying cocoa pod humus. The two feeding habitats are separated in space (2, 6, 13, 14, 18). However, in Tunisia, larvae and adults of *Oryctes* spp. live in the same living and standing trees. Larvae develop in the respiratory roots part, at the periphery of the stem and on the basal part of the crown, feeding at the interface of dead and living tissues (16).

RESUME

Soltani R. 2014. Observations sur la biologie et l'écologie d'*Oryctes agamemnon arabicus*, ravageur du palmier dattier au sud tunisien. Tunisian Journal of Plant Protection 9: 131-142.

Oryctes agamemnon arabicus est une espèce exogène introduite accidentellement dans les oasis de Mrah Lahouar de Tozeur vers les années 1980 et officiellement signalée dans le sud-ouest Tunisien en 1995. Ce ravageur étroitement associé au palmier dattier s'est dispersé dans certains oasis du sud-ouest tunisien, couvrant actuellement 3310 ha. Les sites de reproduction préférés sont les palmiers vivants.

Les attaques de ce ravageur concernent les différentes parties de la plante et se localisent au niveau des racines respiratoires, des composants externes de la tige et aux bases vertes les plus âgées de la couronne. Le site de reproduction peut être lui-même le site de ponte, d'alimentation des larves, de nymphose et d'émergence des adultes. Dans certains cas, les scarabées sont attirés par les tas de fumier existants à l'intérieur des oasis et enterrés dans le sol sous forme de compost. Le cycle de vie des stades immatures, de l'œuf à l'émergence des adultes, sous des conditions naturelles est en moyenne de 319 jours et il est dominé par le développement des larves qui représente 89.6% de l'ensemble du cycle. Par conséquent, les larves représentent les stades nuisibles de cette espèce. Les femelles préfèrent déposer leurs œufs dans des sites cachés au niveau du palmier et qui sont caractérisés par la présence de matériel friable. La fécondité enregistrée pour 43 femelles est en moyenne de 26,62 œufs/femelle. La femelle pond ses œufs séparément en laissant un espace entre les uns et les autres et préfère changer le site de ponte avant de finir son stock d'oeufs. La menace d'*O. agamemnon arabicus* réside dans l'attaque des racines respiratoires. En effet, après plusieurs années d'attaques successives de ces racines par plusieurs générations, les tunnels larvaires s'interpénètrent et évoluent pour former un grand trou qui affaiblit le support de base de la plante et conduisent à son effondrement soudain par les vents.

Mots clés: Biologie, cycle de vie, écologie, *Oryctes agamemnon arabicus*, palmier dattier, sud ouest tunisien

ملخص

سلطاني، رسمي. 2014. ملاحظات حول بيولوجيا وايكولوجيا حشرة *Oryctes agamemnon arabicus*، آفة نخيل التمر في الجنوب التونسي. Tunisian Journal of Plant Protection 9: 131-142.

تعتبر حشرة الأوركتاس (*Oryctes agamemnon arabicus*) من الحشرات الدخيلة على البلاد التونسية حيث تم إدخالها لأول مرة في واحات مراح لحوار من ولاية توزر، في سنوات 1980 وتم الإعلان عنها رسميا في الجنوب التونسي سنة 1995. هذه الآفة المرتبطة ارتباطا وثيقا بنخيل التمر تنتشر حاليا ببعض واحات الجنوب الغربي التونسي، حيث تبلغ المساحة المتضررة ما يقارب 3310 هك. وتعتبر أشجار النخيل الحية من أفضل مواقع تكاثر وعيش مختلف أطوار هذه الحشرة. وتقع الهجمات على مختلف أجزاء النخلة دون استثناء من ذلك الجذور التنفسية والمكونات الخارجية للساق والمنطقة القاعدية من الجريد الأخضر. ويمثل موقع النمو نفس موقع التزاوج ووضع البيض وتغذية ونمو اليرقات والتعذر وظهور الحشرات البالغة. وتنجذب الخنافس في بعض الحالات إلى أكوام السماد المتواجدة داخل الواحات في خنادق على شكل مستسمد. تدوم دورة حياة للمراحل غير الناضجة للحشرة، من البيضة إلى ظهور البالغات، في المتوسط 319 يوما تحت الظروف الطبيعية للواحات حيث تتميز بهيمنة مرحلة نمو اليرقات والتي تمثل 89.6٪ من إجمالي الدورة. وبالتالي، تشكل مختلف الأطوار اليرقية المرحلة الضارة لهذه النوع. وتفضل الإناث وضع بيضها في المواد المتفتتة داخل المواقع المخفية من شجرة النخيل. وبلغ معدل الخصوبة المسجلة بالنسبة إلى 43 أنثى ما يقارب 26.62 بيضة/الأنثى. يوضع هذا البيض بطريقة منفردة ومتباعدة بعض السنتيمترات داخل العديد من المواقع المتواجدة على أشجار النخيل. أما في ما يخص التهديد الفعلي لحشرة الأوركتاس، فيكمن أساسا في مهاجمة الجذور التنفسية، حيث أنه بعد سنوات عديدة من الهجمات المتتالية لهذه المنطقة من الجذور بواسطة عدة أجيال من الحشرة، تتكون شبكة من الأنفاق اليرقية التي تتداخل وتتطور لينجر عنها تكون حفرة واسعة أسفل النخلة وهو ما يؤدي إلى إضعاف دعمها القاعدي يؤدي لاحقا إلى انهيارها المفاجئ بمفعول الرياح.

كلمات مفتاحية: ايكولوجيا، بيولوجيا، الجنوب الغربي التونسي، دورة الحياة، نخيل التمر، *Oryctes agamemnon arabicus*

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