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The variability in the larval morphology of *Hyles tithymali* (Boisduval, 1832) of La Gomera (W. Canary islands, Spain) and the dilemma of its subspecific ascription

(Lepidoptera, Sphingidae)

by

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Abstract: The morphology of the larvae and imagos of *Hyles tithymali* (Boisduval, 1832) of La Gomera island is studied. The previous population is compared with *Hyles tithymali phaelipae* Gil-T. & Gil-Uceda, 2007, of El Hierro and La Palma islands (Gil-T., 2010); and with the nominal subspecies (Tenerife, Gran Canaria, Lanzarote and Fuerteventura islands). The larvae of La Gomera, not well known, show three types of eye-spots, unlike the two described subspecies in the Canary Islands: 22,50% with horizontally elongated subdorsal eye-spots, with the black border of each eye-spot reduced to a dorsal and a ventral black stripe, both horizontally separated (similar to those in *H. t. phaelipae* Gil-T. & Gil-Uceda); 60% with round subdorsal eye-spots (same as in the nominal subspecies); and 17,50% with intermediate eye-spots. In 95% of the grown larvae (L5) of the available sample from La Gomera, all the eye-spots are of orange-ochre colour, like in *H. t. phaelipae* Gil-T. & Gil-Uceda - while in *H. t. tithymali* (Bdv.) the colour is red, pink or white (with several intermediate shades of colour between them). The morphology of the imagos of *H. tithymali* (Bdv.) of La Gomera is similar to the nominal subspecies, but not like in *H. t. phaelipae* Gil-T. & Gil-Uceda.

The larvae of *H. tithymali* (Bdv.) of La Gomera feeds as hostplant an *Euphorbia* not mentioned until now for *H. tithymali* (Bdv.) (s. l.) in the Canary island: *Euphorbia berthelotii* Bolle, an endemic plant in this island.

Because of the mixed features existing in the larvae of La Gomera, present in the two subspecies of *H. tithymali* (Bdv.) of the Canary Islands, and with the purpose to clarify its taxonomical ascription, as a diagnostic tool, I have examined the results of two experimental crossings in captivity: a) F1 from a ♂ of this taxon (La Gomera) with a ♀ from Fuerteventura island (nominal subspecies); and b) F2 from the previous offspring.

The origin of *H. tithymali* (Bdv.) of La Gomera, its relationship or kinship with *H. t. phaelipae* Gil-T. & Gil-Uceda and the nominal subspecies is discussed and its final taxonomic position is proposed.

Resumen: Se estudia la morfología de las larvas e imagos de *Hyles tithymali* (Boisduval, 1832) de la isla de La Gomera. La anterior población se compara con la subespecie *Hyles tithymali phaelipae* Gil-T. & Gil-Uceda, 2007, de las islas de El Hierro y La Palma (Gil-T., 2010); y con la subespecie nominal (islas de Tenerife, Gran Canaria, Lanzarote y Fuerteventura). Las larvas de La Gomera, no bien conocidas, muestran tres tipos de ocelos, a diferencia de la dos subespecies descritas en las islas Canarias: 22,50% con ocelos subdorsales horizotalmente alargados, con el borde negro de cada ocelo reducido a una raya negra dorsal y otra ventral ambas separadas hori-

zontalmente (similares a las de *H. t. phaelipae* Gil-T. & Gil-Uceda); 60% con ocelos subdorsales redondos (igual que la subespecie nominal); y 17,50% con ocelos intermedios. En el 95% de las larvas desarrolladas (L5) de la muestra disponible procedente de La Gomera, todos los ocelos son de color naranja-ocre, como *H. t. phaelipae* Gil-T. & Gil-Uceda; mientras que en las otras subespecies de *H. tithymali* (Bdv.) su color es rojo, rosa o blanco (con varios grados de color intermedios entre ellos). La morfología de los imagos de *H. tithymali* (Bdv.) of La Gomera es similar a la subespecie nominal, pero no como *H. t. phaelipae* Gil-T. & Gil-Uceda.
Las larvas de *H. tithymali* (Bdv.) de La Gomera usan como planta nutricia una *Euphorbia* no mencionada hasta ahora para *H. tithymali* (Bdv.) (s. l.) en las islas Canarias: *Euphorbia berthelotii* Bolle, un planta endémica de esta isla.
Debido a las características mixtas existentes en las larvas de La Gomera, presentes en las dos subespecies de *H. tithymali* (Bdv.) de las Islas Canarias, y con el fin de clarificar su adscripción taxonómica, como una herramienta de diagnóstico, he examinado los resultados de dos cruces experimentales en cautividad: a) F1 procedente de un macho de este taxón (La Gomera) con una hembra de la isla de Fuerteventura (subespecie nominal), y b) F2 procedente de la descendencia anterior.
Se discute el origen de *H. tithymali* (Bdv.) de La Gomera, su relación o parentesco con *H. t. phaelipae* Gil-T. & Gil-Uceda y la subespecie nominal y se propone su posición taxonómica final.

Introduction: Between April 20th and 25th 2009, I was able to examine about 70 larvae of *H. tithymali* (Bdv.) (from L1 to L5) in southeast of La Gomera island (Fig. 1: see arrow), and 18 larvae in Fuerteventura island (E. Canary islands; Fig. 1: „FV“). The grown larvae of the L4 and L5 (col- pl. 11: 2 a-c) show the next forms or morphotypes: a) 22,50% with horizontally elongated subdorsal eye-spots, with the black border of each eye-spot reduced to a dorsal and a ventral black stripe both horizontally separated (of the same kind as in *H. t. phaelipae* Gil-T. & Gil-Uceda, see col- pl. 11: 2 a); b) 60% with round subdorsal eye-spots, like the nominal subspecies (the shape, no colour), but in the Gomera the eye-spots are of orange-ochre colour normally (col. pl. 11: 2 c); c) 17,50% with intermediate eye-spots (col- pl. 11: 2 b). In 95% of the grown larvae (L5) of the available sample, all the eye-spots are of orange-ochre colour, similar to *H. t. phaelipae* Gil-T. & Gil-Uceda.

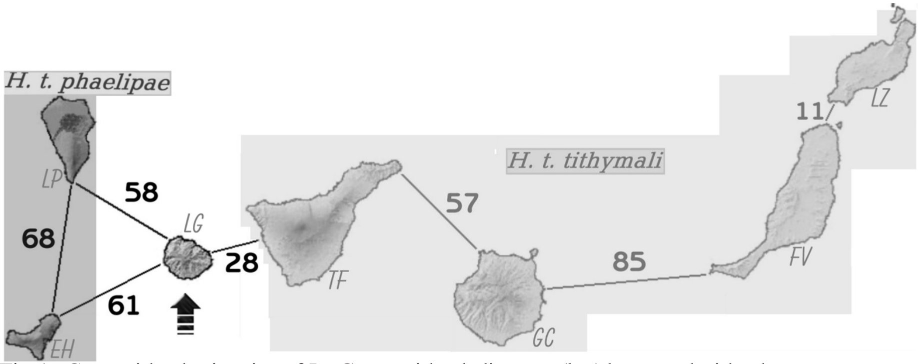

Fig. 1.- Canary islands, situation of La Gomera island, distances (km) between the islands.

According to several authors, the colour of the subdorsal eye-spots de *H. t. tithymali* (Bdv.) can be very intensely red or bright white, or various shades of pink in between, and the shape of the eye-spots with predominance of round eye-spots, very rarely intermediate eye-spots. Note: In

a sample of over 500 larvae examined in Tenerife and Gran Canaria islands, all showed round eye-spots.
The larvae of *H. t. phaelipae* Gil-T. & Gil-Uceda, see Gil-T. & Gil-Uceda (2007) and Gil-T. (2007, 2010), are clearly different to those belonging to the rest of the described subspecies of *H. tithymali* (Bdv.): All larvae exhibit pronounced horizontally elongated subdorsal eye-spots, with the black border of each eye-spot reduced to a dorsal and a ventral black stripe, both being horizontally separated. In 100% of the mature larvae (L4, L5), all of the eye-spots are of a characteristically contrasting orange-ochreous colour. The dorso-lateral row of eye-spots is normally connected by a defined greenish-yellow stripe (Gil-T., 2007), similiar to the caterpillars of *Hyles livornica* (Esper, 1780). In La Gomera, the previous stripe is not visible, vestigial in very few larvae, because its colour is similar to the lateral band of the caterpillar.
The imagos of *H. tithymali* (Bdv.) of La Gomera Island show a similar morphology to the nominal subspecies, but not to *H. t. phaelipae* Gil-T. & Gil-Uceda.
With this mixture of typical characteristics of the two subspecies of *H. tithymali* (Bdv.) of the Canary islands, in the current work, I attempt to define the dilemma of deciding the taxonomic position of the taxon of La Gomera island: may it be included within one of the two subspecies of the Canary islands? or can it be regarded as the result (current or former?) of a intermediate mixture between *H. t. phaelipae* Gil-T. & Gil-Uceda and the nominal subspecies?.
An hypothetical origin of the taxon of La Gomera and its relationship or kinship with the populations of *H. tithymali* (Bdv.) nearest islands, using a paleogeographic synthesis, is hereby discussed.

Material and Methods: Around 70 larvae were collected in La Gomera and reared until their pupation. I also was able to collect 18 larvae of the nominal subspecies (typical eye-spots of colour red and round shape) in the southwest of Fuerteventura Island (Jandia peninsula). With their imagos, I made two different crosses in captivity: one between a ♂ of *H. tithymali* (Bdv.) from La Gomera and a ♀ of *H. tithymali* (Bdv.) from Fuerteventura (result of F1: 87 larvae); a further crossing was made between a pair (F1) of the previous offspring (result of F2: 62 larvae).
Samples of larval varieties or forms obtained (all in L4-L5, with well defined morphology) were photographed laterally. From the photos of the larvae most characteristic, representing their entire range of variability, several sections were selected to compose the figs. 3, 4 in col. pl. 11.

Results

Morphology and ecology of the larvae

The larvae fed on *Euphorbia berthelotii* Bolle, an endemic plant in La Gomera. This *Euphorbia* has not been mentioned until now for *H. t. tithymali* (Bdv.) in the Canary Island. In El Hierro and La Palma Islands (*H. t. phaelipae* Gil-T. & Gil-Uceda) the hostplant is *Euphorbia lamarckii* Sweet (=*E. obtusifolia* Poir = *E. broussonetii* Willd ex Link).

	elongate	elongate	intermediate	intermediate	round	round
	orange-ochre	red-pink	orange-ochre	red-pink	orange-ochre	red-pink
Gomera	22,50%	-	17,50%	-	55%	5%
	From F_0 (♂ Gomera x ♀ Fuerteventura) the results are:					
F1	7,41%	3,70%	11,11	14,81%	-	62,96%
F2(F1xF1)	10,34%	10,34%	20,69%	-	-	58,62%

Table 1: Subdorsal eye-spots: percentage joint shape with colour.

	elongate	intermediate	round
Gomera Island	22,50%	17,50%	60%
From F_0 (♂ Gomera x ♀ Fuerteventura) resulted:			
F1	11, 11%	25, 93%	62, 96%
F2 (F1 x F1)	20, 69%	20, 69%	58, 62%

Table 2: Subdorsal eye-spots: percentage according to their shape.

In La Gomera, the grown larvae of L4, and L5 (col. pl. 11: 2, 3; tab. 1, 2) presented the following forms or morphotypes (note: 95% of the sample with eye-spots of orange-ochreous colour, predominant colour, see Table 3):

a) 22,50% with horizontally elongated subdorsal eye-spots, with the black border of each eye-spot reduced to a dorsal and a ventral black stripe, both horizontally separated, in the same way as in *H. t. phaelipae* Gil-T. & Gil-Uceda [col. pl. 11: 2, 3 row on top; also see Gil-T. (2007)] .

b) 60% with round subdorsal eye-spots, similar (shape) to the nominal subspecies, but contrarily in La Gomera these round eye-spots are of different colour (col. pl. 11: 2, 3 row at bottom): of them (Table 1) 55% are orange-ochre (a colour that does not exist in the nominal subspecies) and 5% are red-pink.

c) 17,50% with intermediate eye-spots (col. pl. 11: 2, 3 central row).

From F1 [F_0 : ♂ *H. tithymali* (Bdv.) from La Gomera x ♀ *H. tithymali* (Bdv.) from Fuerteventura] the grown larvae (col. pl. 11: 4; Ttables 1, 2) showed the following morphotypes (62,96% with red-pink eye-spots, predominant colour):

a) 11,11% with horizontally elongated subdorsal eye-spots (col. pl. 11: 4 row on top). Of them (table 1) the 7,41% are orange-ochreous and the 3,70% are red-pink.

b) 62,96% with round subdorsal eye-spots (col. pl. 11: 4 row at bottom), all of red or pink colour (Table 1).

c) 25,93% with intermediate eye-spots (col. pl. 11: 4 central row), of them (tab. 1) the 11,11% are orange-ochre and the 14,81% are red-pink.

From F2 (♂ F1 x ♀ F1) the grown larvae showed the following morphotypes (the larvae are similar to those of col. pl. 11: 4; red-pink eye-spots are predominant, 58,62%):

a) 20,69% (Table 1 & 2) with horizontally elongated subdorsal eye-spots. Of them (tab. 1) 10,34% are orange-ochre and 10,34% are red-pink.

b) 58,62% with round subdorsal eye-spots, all of red or pink colour (tab. 1).

c) 20,69% with intermediate eye-spots, all of orange-ochreous colour.

	orange-ochre	red-pink
Gomera Island	95%	5%
From F_0 (♂ Gomera x ♀ Fuerteventura) these were the results:		
F1	18, 52%	81, 47%
F2 (F1 x F1)	10, 34%	89, 66%

Table 3: Colour subdorsal eye-spots.

In Table 3 we can see an almost identical percentage of red-pink and orange-ochreous between

F1 and F2 because the samples of larvae F1 (87 larvae) and F2 (62 larvae) were not identical.

Morphology of the adults

In Danner et al. (1998) two imagos of *H. tithymali* (Bdv.) from La Gomera are illustrated, they are considered as nominal subspecies.

In col. pl. 11: 5 we can see a typical imago from La Gomera. It shows a identical morphology to the nominal subspecies: mainly, in the forewing, the median stripe (col. pl. 11: 6) is wider than in *H. t. phaelipae* Gil-T. & Gil-Uceda (narrower in its total length) and of pale creamy colour [see Gil-T. & Gil-Uceda (2007) and Gil-T. (2010)].

The imagos from F1 and F2 (from F_0 ♂ La Gomera x ♀ Fuerteventura) showed a morphology similar to the nominal subspecies also.

Discussion: May we include this population in one of the two subspecies of *H. tithymali* (Bdv.) of the Canary islands?: Absolutely not. The 22,50% of the larvae are similar to *H. t. phaelipae* Gil-T. & Gil-Uceda (tab. 1, 2: elongated and orange-ochreous eye-spots) and only 5% (round and red-pink eye-spots) are similar to the nominal subspecies. The rest are not similar to either of the larvae of the two subspecies. The predominant morphotype (round and orangeous-ochre eye-spots, 55%) is typical of La Gomera Island.

Should we consider this population as a mixture between two Canary islands subspecies?, or a result of a former or current mixture between the both subspecies?: The two experimental cross-breeds, carried out in captivity, previously discussed, aimed to determine whether the morphology of larvae and imagos are preserved in successive generations. We may see in tab. 2 that the round eye-spots in the three generations (shape, not colour) are predominant, in a similar percentage: between 58,62% and 62,96%. The proportion of elongated eye-spots does not exceed one third of the total samples. On the other hand, in tab. 3 we are able to see an outstanding contrast in the high percentage of orange-ochreous eye-spots in the sample of larvae of La Gomera.

The above data (tab. 2) are consistent with the theory of being an intermediate population or the result of a mixture of the two subspecies above, with an exemption of the sample (tab. 3) of La Gomera were the orange-ochreous eye-spots (95%) are predominant and the red-pink colour is very rare (5%).

In the fig. 1 we can see that La Gomera is only 28 km far for Tenerife Island. The presence of larvae, in the first island, with predominant orange-ochreous eye-spots (95%) discards the hypothesis of a constant current genetic exchange between these islands because the larvae with red-pink eye-spots would appear in a percentage similar to those obtained in F2 and F1. But if this genetic exchange took place tens of thousands years ago, how would this have influenced their current morphology?

Paleogeography and hypothesis on the origin and parentage of *H. tithymali* (Bdv.) of the La Gomera

The oldest islands of the Canary islands are La Gomera (12 My), Tenerife (15 My), Gran Canaria (16 My), Lanzarote (19 My) and Fuerteventura (22 My). El Hierro and La Palma are the youngest islands, around 1.1 My and 1.6 My, respectively. The Canary Islands have a volcanic origin, according to the global dynamics of plate tectonics. There are several theories to explain their evolution and development process, but none have yet been adopted as the true one. The islands are organized through axles or structural guidelines (fractures in the oceanic crust) that

connect to each other. These structural guidelines are responsible for the geographical situation of the archipelago. There are three basic axes (Fig. 1): one with northwest-southeast, which includes the islands of La Palma (LP), Tenerife (TF) and Gran Canaria (GC); another in a northeast-southwest direction, linking Tenerife (TF), La Gomera (LG) and El Hierro (EH); and a further one with the same direction as the latter, with Lanzarote (LZ) and Fuerteventura (FV).
In the last Quaternary glaciation („only" 18,000 years ago), in which the sea level was about 120 m below the current level, the geographical landscape of the Canary Islands was quite different from today. At that time, Fuerteventura and Lanzarote formed a single island („Mahan"), and was located just 60 km from the African continent (presently the shortest distance is 96 km). Furthermore, between the south of Fuerteventura and Gran Canaria existed at that time the „Amanay" island, about 100 km2, which nowadays a submarine bank at only 25 meters from the sea surface. The geographical setting before the last Quaternary glaciation very probably was even more different; this should taken into account in any hypothesis about biogeography, population or paleoecology.
The colonization of the different Canary islands by the taxon *H. tithymali* (Bdv.) had its origin in Africa, started to begin after the formation of the first islands, in accordance to the geological history of the islands, undoubtedly as a consequence of passive wind dispersal process (common meteorological phenomenon in the Canary archipelago) coming from the Sahara in a direction from east to west. The smallest distance from the eastern islands (fig. 1: LZ and FV) to the African continent, and from there to Gran Canaria, facilitated the colonization of the other islands. Evidently this colonization was more recent in El Hierro and in La Palma (fig. 1: EH and LP) than in the others. A similar taxon to *H. t. phaelipae* Gil-T. & Gil-Uceda evolved in one (La Gomera according to their age -12 My-?) or several of the western islands in a different manner than those from the rest of the islands. The distance between these islands, tens or hundreds of thousands of years ago, was most probably very much shorter than the current, which facilitated the dispersal of the previous taxon among the three islands. Subsequently, La Gomera (fig. 1: LG), due to displacement of some of the structural guidelines mentioned above, in an indeterminate time, changed its position on Tenerife (TF), which favoured the genetic exchange between populations of *H. tithymali* (Bdv.) of Tenerife and La Gomera, giving rise to a taxon similar to the current (intermediate population). The actual distance between the two previous islands is only 28 km, perhaps (not likely) this genetic exchange still continues, but it must be very reduced because as previously mentioned the orange-ochreous eye-spots are still predominant (95%; dominant trait), and the trait „red eye-spots" seem to be masked or diluted within in the total population of this taxon. The result obtained in F1 and F2 [from ♂ *H. tithymali* (Bdv.) La Gomera x ♀ *H. tithymali* (Bdv.) Fuerteventura], where the red-pink eye-spots are predominant (81.47% and 89.66% respectively; dominant trait), the inverse of the population of La Gomera, indicates that the latter population is a result of a very ancient genetic exchange, because the trait „red-pink eye-spot" is recessive, very rare, in La Gomera, which would not happen if the contact between the populations of *H. tithymali* (Bdv.) of Tenerife and La Gomera were more recent.
The absence of contact between the populations of *H. t. phaelipae* Gil-T. & Gil-Uceda (El Hierro and La Palma islands) and the nominal subspecies is demonstrated: the genetic isolation is the only way to maintain the morphological characteristics of that subspecies.
For all these reasons, I propose that the population of *H. tithymali* (Bdv.) of La Gomera Island is considered as an intermediate population or the result of a very ancient mixture of the two

subspecies of the Canary Islands. I think it is not necessary to describe this population at that moment.

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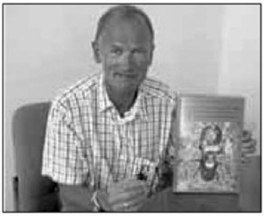
Buchbesprechung

Zur Buchbesprechung Seite 190, 220 und 234

Krabbeltiere faszinierten Detlef Mader von Kindheit an

Der promovierte Geologe aus Walldorf veröffentlicht ein 418 Seiten starkes Buch über das Vorkommen von Hirschkäfern in der Region



Der in Walldorf lebende Detlef Mader ist vom Hirschkäfer hingerissen. Foto: kaz

Von Karin Katzenberger-Ruf

Rhein-Neckar. Was bewegt einen Mann, ein 418 Seiten starkes Buch über den Hirschkäfer zu schreiben? Detlef Mader aus Walldorf war von Kindheit an von Insekten fasziniert. Es begann damit, dass der gebürtige Rheinländer als Zehnjähriger im heimischen Garten einen Zitronenfalter beobachtete, der im Sonnenlicht hin und her flatterte. Sein Interesse für die Wunder der Natur war geweckt. Später kam Mader zum Studium der Geologie nach Heidelberg, spezialisierte sich auf den Buntsandstein, war für seine Studien beziehungsweise für seine Doktorarbeit viel im Gelände unterwegs und veröffentlichte zahlreiche Fachbücher.

Einen Hirschkäfer bekam er erstmals im Jahr 1974 zu Gesicht. Inzwischen steht der Käfer, der zu den größten und auffälligsten in Europa gehört, auf der Roten Liste. Schließlich ernährt er sich ausschließlich von Totholz und ist, wenn überhaupt, vor allem in Eichenwäldern anzutreffen. Möglicherweise haben die über Jahrzehnte zu aufgeräumten Wälder seinen Bestand gefährdet. Oder der Hirschkäfer hat sich einfach gut versteckt. Mader, der früher hauptberuflich in der Erdgas-Industrie beschäftigt war und sich vor sieben Jahren als Immobilien-Makler selbstständig machte, hatte am 1. Juni letzten Jahres sein Schlüsselerlebnis. Das fiel ihm ein Hirschkäfer direkt vor die Füße. Als er ein paar Tage später eine ganze Horde von Hirschkäfern um einen Baum kreisen sah, war ihm klar: „Daraus muss ich was machen". Also startete er unter anderem in der RNZ einen Aufruf und wollte wissen, wer in der Region die Insekten sonst noch beobachtet hat. Die Reaktion überraschte ihn.

In seinem Buch, das unter dem Titel „Populationsdynamik, Ökologie und Schutz des Hirschkäfers (Lucanus cervus) im Raum um Heidelberg und Mannheim" erschien, hat er die Seiten 118 bis 349 dann auch für akribisch aufgelistete Fundmeldungen aus der Region reserviert. Wobei der Branich in Schriesheim als Wohngebiet in Hanglage eine echte Hochburg für Hirschkäfer zu sein scheint. Sie werden dort quasi jedes Jahr gesichtet, obwohl das eigentliche Käfer-Leben gerade mal vier bis sechs Wochen dauert.

Die Entwicklung vom Ei bis zur zehn Zentimeter langen Larve und zur Verpuppung unter der Erde dauert etwa fünf Jahre. In der „Flugphase" von Mai bis Juli sind die Insekten dann vor allem auf Paarung und Vermehrung programmiert und bei Neumond und Vollmond besonders aktiv.

Trotz seines „Geweihs" ist der Hirschkäfer nicht vor Fressfeinden sicher. Wohl auch, weil er sich eher behäbig bewegt. Wer ein Exemplar auf dem Rücken liegend antrifft, sollte ihm übrigens auf die Beine helfen... Zur Buchvorstellung hat Mader einen halben Hirschkäfer mitgebracht. Ihm hat vermutlich ein Specht den protein- und fettreichen Hinterleib abgebissen. Auch ohne diese „Vorratskammer" kann der Käfer noch einige Tage überleben. Hirschkäfer „in Aktion" sind übrigens am besten kurz nach Sonnenuntergang an Waldrändern zu beobachten. Nach wie vor ist der Buchautor an Fundmeldungen über die Exemplare aus der Familie der „Schröter" interessiert, freut sich aber genauso über Berichte über die kleineren Nashornkäfer. Er ist selbst nach wie vor viel im Wald unterwegs, morgens ab etwa 6 Uhr zum „Power-Walking." An seinem wissenschaftlichen Buch arbeitete er etwa ein Jahr lang.

ⓘ **Info:** Das Buch über die Hirschkäfer ist in einer Auflage von 300 Stück im Verlage Regionalkultur (ISBN 978-3-89735-594-1) erschienen, aber auch direkt über den Autor (Telefon: 06227/4252, E-Mail: dr.detlef.mader@web.de zu beziehen. Dies ist auch der Kontakt zu Beobachtungen in Sachen Hirsch- oder Nashornkäfer.