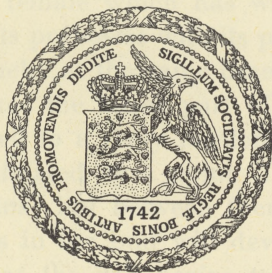


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CHERMES ABIETIS GALLS
AND SQUIRRELS

BY

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KØBENHAVN
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I. Introduction.

By "galls" are understood various peculiar transformations of tissues of plants; they are produced by insects to which they provide both shelter and nutriment.

Curator of the Insect Department of the Zoological Museum of Copenhagen KAI HENRIKSEN at his death left a manuscript on Danish galls which Dr. SØREN TUXEN, Assistant Curator, has published with great reverence. This work¹ comprises 571 gall-forming species of arthropods; the host plants are listed and a description is given of the galls. Both among the *Coleoptera*, *Lepidoptera*, *Hymenoptera*, *Diptera*, *Hemiptera*, and *Acarina* there are species producing galls.

The gall which I am going to mention in the following sections are commonly found on common spruce (*Picea excelsa*, now called *Picea abies*); it is situated at the base of the shoots from last year (fig. 1). It resembles a little cone or a pineapple in miniature—in scientific works it is often called »the pineapple gall« ("anas-gall").

As is known, these galls are produced by the plant-louse *Chermes abietis*.² The female which has wintered in the larval stage in spring inserts its proboscis with its piercers at the base of a bud and begins to suck; at the same time it exudes a salivary secretion,³ which makes the basal part of a larger or smaller number of needles swell to a scaly portion; on this portion the rest of the needle is situated as a point. The scales about each other with their margins; but between them there are cavities. The rest of the needles in the bud will develop normally.

At the same time as the gall begins to develop, the aphid

¹ See under literature p. 15.

² *Chermes abietis* Linnaeus, Systema Naturae, Ed. decima, 1758, p. 454.

³ On the supposed qualities of the salivary secretion (Poisonous matter? Hormonal effect?) information and references to literature are found in BEIER (l. c. pp. 2331—2332).

grows—it attains a size of 1.5 mm—and surrounds itself with a dense felt of wax threads. It now lays up to 150 eggs (fig. 2) thus becoming the ancestress (*fundatrix*) of a number of larvae,



Fig. 1. Galls of *Chermes abietis*. The chambers are closed. 22.VII.46.—¹/₁.

which creep in between the scales in the gall, where they begin to suck.¹ By the activities of the larvae the basal parts of the needles are transformed into shield-shaped plates with yellow-brown coalescing edges;² thus closed cavities are formed, in

¹ Cf. JUDEICH und NITSCHKE, p. 1222; THOMSEN, p. 97.

² According to BÖRNER (p. 222) these plates are not formed by the basal parts of the needles, but by the stalked portion on which the needles are situated and which morphologically belongs to the bark.

which the larvae are enclosed (fig. 3). When the larvae have gone through a number of moults the gall will open along the coalescent edges;¹ the larvae will leave the chambers (fig. 4), develop wing rudiments (nymphs), will shed their skin for the last time and get fully developed wings. This generation no. 2 is

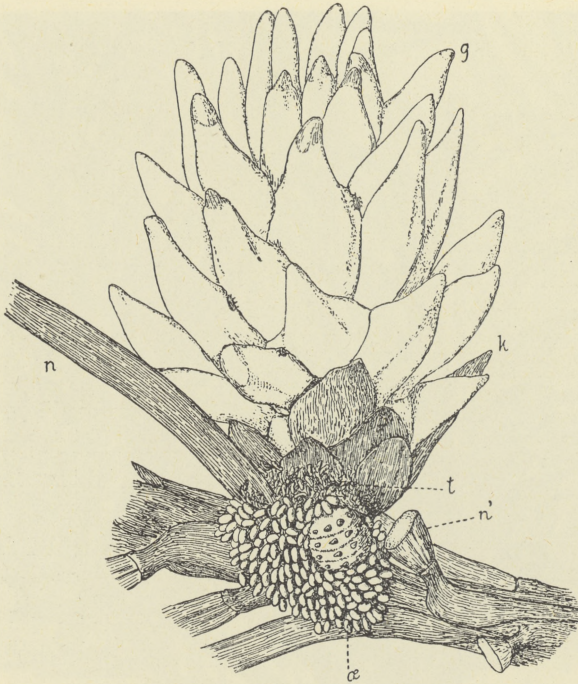


Fig. 2. Young gall of *Chermes abietis*, at the base of which the egg-laying female (*fundatrix*) is sitting. 28.V.20. *æ* eggs; *t* empty egg shells which have held the young plant-lice which are seen creeping about the gall; *g* green needle points (the remaining part of the needles is pale); *k* bud scales, *n* and *n'* cut off needles.—⁵/₁. After Boas.

female like generation no. 1 (*fundatrix*). A number of these females will remain on the spruces² and deposit their eggs on the

¹ As late as August 26, I have found a few galls which had not yet opened.

² Others of these females will fly to larks (*Larix europæa*), where they will lay their eggs from which wintering larvae will hatch and next year develop into wingless females; these will produce winged females, which will migrate back to the spruce, where their progeny will develop into wingless males and females; their progeny contribute to forming generation no. 1 next year on the spruce.—No galls are produced on larks (BEIER l. c. p. 2414).—There has been much discussion as to whether *Chermes* on spruce (*Ch. abietis*) and that on lark (*Ch. viridis*)

needles; the larvae emerging from these eggs will winter and next year become *fundatrices*.

The shield-shaped basal parts of the needles are at first green and succulent, later on brown, ligneous, in winter black-brown.

There are galls which consist of one or two cavities only;



Fig. 3. Longitudinal sections of galls of *Chermes abietis* cut off on 9.VIII.22. The chambers are closed, and the plant-lice are seen in them. In the figure on the left the gall has developed round the shoot, in the figure on the right only on one side of the shoot.— $\frac{2}{1}$. After Boas.

but the average size is like a hazel-nut or walnut. They are from egg- to ball-shaped or more elongate and may attain a length of 40 mm. The galls may be produced on one side of a shoot only or round it (fig. 3).

belong to the same species or to different species. The last author who has been engaged on this problem, is SCHNEIDER-ORELLI, who on the basis of thorough observations and numerous rearing experiments drew the conclusion (l. c. p. 102) that "*Chermes abietis* und *Chermes viridis* nicht zwei selbständige Spezies, auch nicht Subspezies oder "biologische Arten" sind, sondern zwei, wenn auch weitgehend, so doch nicht vollständig getrennte Entwicklungszyklen (Parallelreihen) der Chermidenart *Chermes abietis* darstellen".

II. The Investigation.

In my diary under August 14, 1927, I find the following note: During an excursion to Geel Skov¹ I found bitten-off twigs of common spruce with the cone-like galls of *Chermes abietis*. Apparently,



Fig. 4. A gall of *Chermes abietis* which has opened, whereupon the larvae have left the chambers. 28.VIII.46.—²/₁.

these twigs had been treated in quite the same way as observed by Docent STAMM in the summer of 1909 in Annebjerg Skov near Nykøbing, Sjælland. STAMM has given a good and detailed description of the galls which he found to have been treated by

¹ The localities at which I made my investigations are all situated in North Sjælland.

Cross-bills (*Loxia curvirostra*).¹ The chambers in the galls had been opened, the uppermost wall as well as the point of the needle having been removed and the lowermost parts of the chambers remaining as flatter or deeper bowls (fig. 5 above). It was striking, however, that the treated galls which I found (fig. 5 below) were lying under trees in which squirrels (*Sciurus vulgaris*) had been at work; for under the spruces there were also cones treated by squirrels. It was all but obvious, therefore, that these galls had been gnawed by squirrels, either for the sake of the succulent green tissue formed by the swollen leaf bases, or for the sake of the plant lice enclosed in the chambers, or for both. I found no cones treated by Cross-bills.

This observation made me go to the Zoological Garden of Copenhagen next day, in which there was a cage with a Danish squirrel. By the assistance of Director ALVING, I had some green cones of spruce and some *Chermes* galls placed in the feeding vessel of the squirrel. The squirrel gnawed all the scales off the cones in order to get at the seeds; the galls were gnawed quite in the same way as those found in Geel Skov. This supported my view that the squirrel will also gnaw these galls in nature. It was curious that the squirrel had not forgotten its habits although it had been in the Zoo for many years and had not had the opportunity to treat cones, let alone galls, during that time.

A fortnight later, on August 28, 1927, I made an excursion to Rude Skov. Below several spruces I found many of the peculiarly treated *Chermes* galls, here they were also lying together with cones treated by squirrels. Despite a good deal of search no cones were found which could have been treated by Cross-bills.

On September 4th of the same year I visited Uggeløse Hegn. At that time the squirrel during its migrations had not yet reached Uggeløse Hegn; a flock of Cross-bills was, however, observed, and several hundreds of spruce cones treated by this bird were found. Some treated *Chermes* galls were also found; according to conditions they were supposed to have been treated by Cross-bills, but they could not be distinguished from those treated by squirrels.

On September 18, 1927, I again visited Uggeløse Hegn;

¹ R. H. STAMM, l. c. p. 45—49. On the great invasion of Cross-bills which took place in 1909, cf. WHITAKER (l. c.).



Fig. 5. Figure above: Galls gnawed by Cross-bill. After STAMM.
Figure below: Galls found together with cones gnawed by squirrels.
Both figures on a slightly reduced scale.

numerous cones treated by Cross-bills and many *Chermes* galls gnawed by Cross-bills were found.

On September 26, 1927, I was in Kongelunden on Amager; a great number of cones had been gnawed by Cross-bills and under one of the trees particularly many *Chermes* galls¹ treated by Cross-bills were found.

Until the summer of 1946, in the intermediate nineteen years, I have constantly been interested in this problem, and during excursions to the woods in the vicinity of Copenhagen I have looked for *Chermes* galls. Again and again I found great numbers of treated galls always lying together with spruce cones gnawed by squirrels; but never did I see Cross-bills or cones treated by this bird.

When the Zoological Garden in 1945 came into possession of six young ones of Swedish squirrels, I had several times towards the end of June and middle of July, with the assistance of Director REVENTLOW, *Chermes* galls which had not yet opened, placed in the cage of these animals.² Hardly had the small squirrels caught sight of the *Chermes* galls before they took them and began to gnaw them. On some of the small twigs there were two galls, each at the base of its shoot; and so eager were the animals to partake in this meal that I saw two squirrels gnaw simultaneously each of its gall on the same twig. On this occasion I was able to ascertain partly that the animals devoured the gnawed parts of the galls, partly that the gall chambers immediately after the treatment proved to be emptied of plant-lice.

Through all these years I had not, however, succeeded in catching a squirrel in the act of treating *Chermes* galls. But on Sunday the 18th of August 1946 I was on an excursion to Tokkekøb Hegn. In a place with tall common spruces I found lots of bitten-off shoots with treated galls, they were lying by hundreds strewn over a fairly large area, and they looked as if they had been gnawed recently (fig. 6).

In another place of the wood there is a row of tall common spruces along a path; under them many *Chermes* galls were lying,

¹ On the great Cross-bill migration which took place in 1927, cf. AD. S. JENSEN (l. c.).

² Rich material for these experiments was provided by Mr. MØHL HANSEN, the taxidermist, who at Lillerød, by courtesy of Mr. P. HANSEN, earthenware manufacturer, was allowed to gather shoots with galls in a clump of young spruces found in Mr. P. HANSEN'S garden. I am much indebted to both these gentlemen.



Fig. 6. *Chermes abietis* galls gnawed by squirrels. Tokkekøb Hegn.
18th August 1946. — On a slightly reduced scale.

all of them treated recently. At the top of one of these spruces I discovered a squirrel in great activity, it ran out on a branch, bit off a twig, began to work at it, and shortly after it let the object go. This was repeated several times. An examination of the ground round the base of the tree gave the result that several shoots with newly treated *Chermes* galls were lying there and nothing else.

Thus I had succeeded, for the first time, in watching a squirrel in nature treating *Chermes abietis* galls; and the task which I had set before me had been finally performed.

These experiences gathered through many years altogether showed me that the squirrel contributes highly to checking the attacks of *Chermes abietis* in the woods. That such attacks involve injurious consequences to the common spruce is evidenced by numerous descriptions and illustrations in forestal literature (cf. fig. 7); and many of us have ourselves seen the injurious effects of these attacks. Many of the shoots attacked wither, and those surviving the attack frequently acquire a strong curvature; if the top shoot is affected, the shape of the stem will be spoiled.¹

It appears from the forestal literature which has been accessible to me that it has been proposed to check the damage made by *Chermes abietis* to the common spruce partly by cutting off the young unopened galls and destroying them and their content of plantlice, partly by spraying *fundatrix* with a liquid which will kill the plant-lice without damaging the plant. As far as I can see none of these methods has been completely satisfactory; one almost gets an impression that it is impossible to carry through these experiments. Besides, these means can only be used if young spruces are infested; for none of these means can be applied to the tops of the tall trees where, according to my investigations *Chermes abietis* is equally common and whence it becomes widely spread; at these altitudes the squirrel reigns and contributes to the control.

That the squirrel does damage to the wood in many ways is well known. It may also, however, as has been shown above, be beneficial; and it appears to me that one ought to have a very thorough knowledge of the habits of such an animal, before it should be characterized as exclusively injurious.

¹ *Chermes abietis* also occurs in U.S.A. where it arrived with the common spruce, which was introduced there from Europe. In American literature it is called *Adelges abietis* and has been reported throughout the New England states, particularly in Maine. It occurs in most places where Norway spruce (i. e. *Picea abies*) is growing, and the spruce gall causes serious deformation of young trees—as in Europe.



Fig. 7. Top of a young common spruce with *Chermes abietis* galls. The longitudinal shoot is deformed and all the lateral branches injured. About half natural size. After a photograph by H. NITSCHE.

III. Concluding Remarks.

After observations through many years in spruce woods and repeated experiments in the Zoological Garden the author thus succeeded in demonstrating that the squirrel likes to open galls of *Chermes abietis* and empty them of plant-lice.

The plant-lice and the galls produced by them cause great damage; the affected shoots become deformed or wither, and the shape of the trunk is spoiled if the end shoot is affected. The squirrel thus is beneficial when it devours the plant-lice. Even the tops of the tall trees, where man cannot control the damage, are haunted by it for the sake of the galls. The squirrel thus is not exclusively a noxious animal, as it is generally held to be.

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This paper was translated into English by Mrs. AGNETE VOLSØE. The photographs nos. 1, 4, and 6 were taken by Mr. MØHL HANSEN, the taxidermist.