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THE RÜGEN-HERRING IN SWEDISH  
WATERS WITH REMARKS ON HERRING  
POPULATION PROBLEMS

(Sammanfattning: Rügensillen i svenska vatten,  
jämte kommentarer om problem rörande sillpopulationer)

By

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Summary

In the 1970s, German (DDR) tagging experiments on the spring-spawning Rügen-herring displayed a distinct migration pattern of this stock, between the Rügen area of the Baltic and the Kattegat/Skagerrak.

By Swedish fishery in the southwestern Baltic and the Sound (Öresund) the herring population in question had been exploited on a very restricted scale (mainly as young fish). In the seventies a new coastal winter fishery using wide-meshed herring nets of the very effective monofilament nylon material was introduced in the Öresund and adjacent waters. Furthermore Swedish west-coast fishing vessels started a mid-water trawl fishery during November-March in the southwestern Baltic eastwards to the Bornholm Strait. The mature Rügen-herring, previously overlooked, is thus now holding a fairly prominent position in the Swedish catches from the areas mentioned.

The problem of migration and spawning, and of variation in the Baltic population size is discussed in relation to different spawning areas and migration patterns. The Rügen-herring and the Kattegat spring-spawners have identical meristic characters, although the environmental conditions of the spawning areas, e. g. at Rügen and in the Kattegat must contrast in some respects. This fact indicates close relations and/or some sort of mixing between them.

A new tagging scheme for the two herring populations is suggested in order to get, i.a. a better quantification of the exchange between the southwestern Baltic and the Kattegat and to study the behaviour of the young herring.

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Disregarding some smaller amendments this contribution is identical with a paper read at the Council Meeting of the International Council for the Exploration of the Sea, October, 1984, C.M. 1984/J:16.

Sammanfattning:Rügen-sillen i svenska vatten, jämte kommentarer om problem rörande sillpopulationer

Under 1970-talet visades genom östtyska fiskmärkningar att den s k Rügen-sillen, som leker under vår-försommar i sydvästra Östersjöns grunda kustområden, i stor utsträckning regelbundet vandrade till Kattegatt-Skagerrak under senvår-sommar.

Denna silltyp hade av det svenska fisket endast i ringa utsträckning beskattats i Öresund-sydvästra Östersjön, och huvudsakligen som ung fisk. Under 1970-talet utvecklades i nämnda områden ett nytt vinterfiske efter sill, där man använde stormaskiga och mycket effektiva nät av heldragen nylon. Trålfiskebåtar från västkusten startade samtidigt flyttrålsfiske, främst under november-mars, i sydvästra Östersjön (Falsterbo-Bornholm).

Den vuxna Rügen-sillen hade tidigare i huvudsak undgått fångst här, på grund av att vinter-vår-fisket ägnades åt torsk och andra arter. Vid nätfisket användes därtill länge för småmaskiga garn i Öresund och efter sydkusten. Nu utgör Rügen-sillen en betydande del av sillfångsterna (7 000-12 000 ton per år) i aktuella områden.

Problem rörande vandringarna och leken diskuteras. Möjligen kan eventuella ändringar av vandringsvägar och lekområden ha bidragit till ökad förekomst i Öresund. En komplikation i sammanhanget är att den sill som anses leka i Kattegatt under våren ej kan skiljas från Rügen-sillen på kottal och andra karaktärer, trots miljöskillnader, t ex mellan Rügenområdet och Kattegatt. Detta talar för att sillpopulationerna här är mycket nära släkt med varandra och/eller att det sker en upprepåd blandning mellan dem.

Ny märkningsaktivitet föreslås i avsikt att bl a få en bättre kännedom om utbytets storlek i båda riktningarna mellan Östersjön och Kattegatt samt om den unga sillens uppträdande.

(Mera detaljerad information rörande sillen i Öresund och närliggande vatten kan inhämtas även genom referensen "Otterlind, G., 1984 a" i litteraturlistan på sid 12.)



The waters from the southwestern Baltic, west of Bornholm to the Kattegat, constitute a transition area between the Baltic and the Skagerrak/North Sea. In the Arkona Basin, from Bornholm to the Danish islands, we find a fairly stable brackish water surface layer (depth: c. 30-45 m, salinity: c. 7.5-9.0‰) and a usually thin bottom layer, holding a varying higher salinity. In the Kattegat the situation is reversed: a thin and changing surface layer (c. 10-15 m, usually, and as a rule more than 15‰) below it a thick water layer of high salinity (usually c. 30-34‰, where the depth is sufficient). In the Öresund and the Belts with adjacent waters the environment is more changing as a consequence of varying currents at the surface as well as along the bottom. They may change very much in direction, and a speed up to c. 2 m/sec. has been noted at the surface.

The instable conditions of the Öresund, the Belts and neighbouring waters are, of course, of great importance in relation to the herring stocks, their propagation and migrations.

#### Migration problems in the southwestern Baltic

The migrations of the main spring-spawning herring populations along the Swedish coast, from the Karlskrona archipelago in the south to the Bothnian Bay in the north, are relatively well known for the adult fish. Tagging experiments on about 33 000 herring were conducted here in 1954-76 (cf. Otterlind, 1961, 1962, 1976, 1978). But migrations from this area only slightly affect the southwestern Baltic (W of Bornholm) where other populations dominate, spawning chiefly at the German, Danish, and Polish coasts. Some few recaptures were made at the south coast of Skåne (Scania), where tagging was not performed due to the lack of known suitable breeding grounds. One record only, was reported from Öresund.

Highly valuable results were, however, obtained for the southwestern Baltic from the tagging of spring-spawning, so-called Rügen-herring in the DDR (German Democratic Republic) for some years since 1975, primarily in the shallow waters to southeast of Rügen Island, at Greifswalder Bodden. A regular migration of adult herring was observed between these grounds and, via Öresund, the Kattegat/Skagerrak, going to the latter in late spring and summer, and returning in autumn and early winter (Biester, 1979, with full references).

The German tagging activity has continued and, by 1980, included about 45 000 herring. Investigation of the migration routes can on the whole be regarded as complete, since tagging experiments have also been made on the western side of Rügen, demonstrating migrations through the Belts to and from the Kattegat (Jönsson & Biester, 1981). The general extent and direction of the migrations is shown by Fig. 1.

These results threw new light upon some earlier, smaller tagging experiments which were made from the Danish, Swedish, and German side in the Kattegat, Öresund, and Belts, their interpretation having in part been erroneous (cf. Anon., 1974 & 1980). The latter fact was due to incomplete knowledge of the composition of the herring populations being tagged, and possibly even due to a variability of migration routes. - Jensen (1955), though, had long before drawn the correct conclusion, from his taggings, about the Rügen area's importance



as a spawning ground for spring-spawning herring that passed southwards through Öresund and the Belts from the Kattegat. - The waters in question are mixing areas for different herring stocks (both spring- and autumn-spawners), but herring of the Rügen type are obviously prominent here.

By the Rügen type are here meant the fast growing herring which spawn during spring-early summer in shallow, coastal waters from the Belts to the region east of Rügen in the Arkona Basin.

The connection with Kattegat was also confirmed by the occurrence of *Anisakis nematodes* (larvae) in the adult Rügen-herring of the southwestern Baltic. The degree of infestation increases with age, while the young herring up to 20-22 cm in size (around two years old) usually lack parasites completely here (Friess, 1977; Kühlmorgen-Hille, 1983, and investigations by the present author). Earlier hosts for the worm's larvae are planktonic crustaceans, euphausiids, which are absent in the very brackish Baltic waters. The final host is said to be seal or porpoise.

It was also found rather soon that herring of the Rügen type were not distinguishable by means of the usual meristic characters from the spring-spawning herring of Kattegat (Ackefors, 1977; Biester, 1979).

#### Occurrence and fishing in Swedish waters

The Rügen-herring attracted stronger Swedish interest through the tagging results and a winter fishery established during the 1970s in Öresund and the southern Baltic. It is not only fished there but had long been taken in Kattegat/Skagerrak during the summer and autumn as well - without being identified. It could also be supposed that herring which spawned or were born in Kattegat, might spawn during another year in the southwestern Baltic or around the Belts, and fished there.

In the course of an investigation of herring fishery and herring stocks in Öresund and adjacent waters during 1979-84, the fact that Rügen-herring had long been overlooked in Swedish catches in the Baltic and Öresund was explained (Otterlind, 1984a). When this type was caught in the Kattegat/Skagerrak, it was naturally interpreted as belonging to the Kattegat spring-spawners.

By tradition until the 1970s, herring fishery with gill-nets in Öresund had not been conducted to any significant extent during the cold season. A change was consistently made in late autumn to fishing for cod and other demersal fish. The herring fishery took place mainly in August-October. Then and also at other times, to the degree that fishing went on, too small meshes in the nets were used - even into the 1970s - to allow most of the adult Rügen-herring to be caught (mesh-size: usually 18-22 mm bar-length, sometimes smaller). Trawl fishing in Öresund has been banned by Danish/Swedish agreement since the beginning of this century.

Gill-net fishing at the south coast of Skåne in the Baltic was done in a similar way as regards the season and mesh-size. The same very fixed time pattern of fishing applied largely even to trawl fishing in the southwestern Baltic and the entire south coast of Sweden: cod during the winter-spring and herring in the summer-late autumn.



As a consequence of the herring stock collapse in the North Sea the fishing activities were altered during the 1970s. In the southern Baltic, the Swedish trawling became less seasonal due to the participation of boats from the west coast, and to increased marketing possibilities. It now went on even in wintertime, just as it had always done in the central and northern parts of the Baltic proper (S of the Åland Sea) since trawling was introduced there in the 1950s and 1960s.

The latter fisheries involve chiefly herring that later, in April-June, enter the Swedish archipelago to spawn. These herring, as shown by Swedish tagging results, subsequently undertake feeding migrations to the waters between Gotland and Bornholm, as well as to the Hanö Bay, the waters south-east of Bornholm, and to some extent to the Gdansk Bay. The new winter fishery in the southern Baltic was directed to the stocks spawning in the coastal areas there, i.a. the Rügen-herring.

Herring gill-nets made of nylon were first used in the 1960s, initially manufactured out of spun thread and tending to monofilament in the second half of the 1970s. The latter kind is said by professional fishermen to be as much as 10-15 times more effective than the old cotton nets. In addition, it requires no drying, is less sensitive to low winter temperatures, and fishes well even in daytime.

Winter fishing in the northern Öresund was started by some Swedish west-coast fishermen in 1972 with large-meshed nylon nets intended for herring in Kattegat/Skagerrak, since the trawl fishery in the North Sea had to stop.

Two discoveries were made by the new net fishery. Herring occurred in the northern Öresund which spawned during January-March along the Höganäs-Kullen coast and provided good catches for some years. Moreover, both here and southwards in the Sound, apart from autumn-spawners, large spring-spawning herring of the Rügen type were periodically abundant from the autumn at least until into January.

The normal mesh-size in this net-fishing became 27-28 mm bar-length. Thus, the catch consisted solely of the assortment "0" (max. 8 herring/kg) which gives the best prices. Local fishermen in Öresund and the nearby southern Baltic had somewhat increased their mesh-size of about 18-22 mm during the 1960s, occasionally up to 25 mm bar-length, and they now followed the development in the later 1970s. At present, monofilament nylon gill-nets of 27-28 mm mesh-size are almost exclusively used in professional fishing here.

A sharp decline of the autumn-spawning herring stock around the southern Öresund had been noticed already just after World War II, and spring-spawners are said to dominate from this period in the small fishery for herring (cf. Fig. 2). Evidently the larger spring-spawners were missed, nevertheless, in the gill-net fishery until well into the 1970s.

Unfortunately, market forces have made the herring catch with nets in Öresund and nearby waters a poor index of the occurrence of herring there. For instance, low prices for herring in the past two years have often led to the abandonment of a rich herring fishery in favour of the now more lucrative cod.



As to the herring trawl fishery west-coast boats in the 1970s took up mid-water trawling, mainly in November-March, to the south of the Öresund boundary, Falsterbo-Stevns line, at Kriegers Flak, along the south coast of Skåne, and to the Bornholm Strait. They caught primarily large Rügen-herring. The fishing was sporadic at first, becoming more regular in later years. Some trawl vessels from the Scanian east and south coast were soon joining this fishery. The richest catches of the greatly demanded large herring (around 5-8 per kg) were usually made in December-January. The amount caught here is extremely variable, evidently in relation to hydrographic factors. Occasionally, the herring has stayed too near the Scanian coast to be taken by trawl, while in other cases it has obviously left the Swedish fishery zone.

In sum, it can be said that the adult Rügen-herring, until the 1970s, was not caught in any appreciable quantities by the Swedish fishery in the Baltic and Öresund, but was probably a considerable part of the catch during summer and autumn visits in Kattegat/Skagerrak. The young herring of Rügen type, on the other hand, seems to have long comprised an important part of the catch i.a. for the production of the famous Scanian spiced herring.

There are, however, older data on periodical catches of large herring on the Scanian coasts which must, at least partly, have consisted of the Rügen type (cf. Otterlind, 1984a). The gears then included large-meshed nets, or seines, intended for garfish, mackerel, or salmon.

#### Spawning behaviour and migration

The migration of the Rügen-herring from the Kattegat to the Baltic via Öresund occurs, according to fishing experience in recent years, chiefly during October-December, but good catches have been made in the central Öresund during January as well. Here, the spring-spawners have been seen to appear in dense shoals during November-January, with hard winds from the west that direct the surface current southward (the usual direction is northward). The herring can be abundant at year's end between the Falsterbo headland and Trelleborg in the Baltic, sometimes even in October. Later in winter, it is found also farther towards the Bornholm Strait.

Most of the adult Rügen-herring disappear from the Swedish fishery zone in the later part of the winter, manifestly in order to spawn at the German or neighbouring coasts. But some shoals stay in Scanian waters to spawn primarily in the area between the Falsterbo canal mouth and Trelleborg during April-June. Herring shoals that are probably of this type occur yearly even eastward to the Bornholm Strait in the few pound-nets which are still set during spring for cod, sea trout, eel, and garfish, as well as to a lesser degree for herring. (The usual pound-nets for silver-eel are set out at Midsummer or later.)

Information from fishermen and herring samples to our laboratory show that the spawning near Trelleborg takes place at a depth of about 10 metres over bottoms with small red algae ("sea moss") or bladder wrack. The cod in these waters may then often have



their stomachs full of herring roe. Closer investigation of the spawning area's extent, the time and regularity of spawning at the Scanian south coast should be appropriate. This coast is open and must suffer greater variations of temperature connected with water exchange related to wind and depth, than do the shallow and more wind-sheltered spawning areas around Rügen.

It is plausible to assume that the spawning on the Swedish side varies strongly with the environmental conditions. This is presumably even more applicable to the survival of the larvae. The shallow waters in the bay of Kämpinge and possibly on the south side of the Falsterbo headland may offer an adequate place as a larval nursery in certain years despite their open location.

Fishing does not provide much information about the migration of Rügen-herring out of the Baltic through Öresund in spring-summer. There is no considerable fishing of herring at this time on the Swedish side, either in the southwestern-most Baltic or in Öresund. However, recaptures of the DDR taggings show that some herring, particularly younger fish, go eastwards to the border waters of the Bornholm Basin after spawning (Biester, 1979), a lot of them probably turning westwards later on. In these waters, the Rügen-herring mixes with populations that spawn at Bornholm, in the northwestern part of Hanö Bay, in the Blekinge archipelago, and at the Polish coast.

The migration habits of the young Rügen-herring are not well known, but it presumably spends its first two years mainly in the Arkona Basin and neighbouring waters of the Belts, the Sound and Bornholm.

#### The need for additional taggings

The German taggings of Rügen-herring are of fundamental importance for the understanding of this herring type's occurrence. Yet it is clear that further work will be required, in particular to throw light upon the exchange between the southwestern Baltic and Kattegat/Skagerrak in quantitative terms, and as to variations between years, as well as to reveal the behaviour of the young herring.

Increased tagging activity for the study of relationships between different herring populations is all the more appropriate insofar as small distinctions in meristic characters and otolith characters have often proved to be of little value for the separation (cf. Biester, 1979; Anon., 1983). This is, no doubt, mainly due to varying environmental influences and to changes in spawning areas, sometimes even in spawning times.

The problem of migration between the Baltic and Kattegat/Skagerrak has been treated by ICES, partly through a special "workshop" (Anon., 1983) and partly by its Working Group on assessment of pelagic stocks in the Baltic. The latter, in 1984, has also considered Kattegat-Skagerrak (Div. IIIa) and the waters west of Bornholm (Sub-div. 22-24) as a unit in its stock calculations



(Anon., 1984). The catch in the southwestern Baltic (W of Bornholm excl. Öresund) has, during the last five years, been between 84 000 and 108 000 tonnes which are regarded as consisting primarily of the Rügen type. In the Swedish portion of 7 000-12 000 tonnes, there are probably a good number of herring from the east, since even during the summer half-year the catch is frequently taken at the mouth of the Bornholm Strait. This area is according to the tagging results a mixing zone for herring from both west and east. Most of the herring from waters east and north of Bornholm usually stop here, however (Otterlind, 1962).

Of the DDR taggings, recaptures that are remote in time and space seem to be relatively few. It has been pointed out for example that the Swedish fishery has yielded few finds (Jönsson & Biester, 1981). This is obviously to a great extent due to the type of tag used (a small red plastic label attached with nylon thread), which is easy to overlook and bears a rather unclear text.

The use of sorting machines - generally on Swedish fishing boats - presumably results in the tag often coming loose, and in its escaping observation, even if it stays on the fish. However, yellow-blue Lea-tags with enclosed texts would certainly give a higher rate of recaptures reported, especially outside the vicinity of tagging activities. Every large-scale tagging experiment in future must be combined with repeated information to the fishing fleets so that the tags are taken into consideration more attentively.

Tagging experiments should, in the first place, be made in the Kattegat, both with herring spawning at the coasts in spring and with the fish on feeding migrations during other seasons. Simultaneous, complementary taggings by the same methods are desirable at Rügen, ideally also in the Belts, and if possible at the spawning grounds of Trelleborg. Young herring of the Rügen type, and of spring-spawners from Kattegat, can be tagged with external tags of the Lea type as well, at 1-2 years of age (about 17-20 cm size) - even if the mortality due to tagging is higher than for old, large herring. If possible both external and internal tags should be used. The project requires a comparatively great working effort, and should be repeated at least during two years.

#### Variations in migration behaviour

The experience with tagging of herring along the east and south coasts of Sweden demonstrates that different coastal areas can be chosen by the individual fish for spawning from one year to the next. Sometimes they are widely apart. For example, tagging of a spawning population at Västervik on the east coast gave a record of one herring with gonad stage 4-5 in May next year at Trelleborg on the south coast. Another one from Vaddö at the northwestern Åland Sea was recaptured in the Blekinge archipelago in the same stage and month. Taggings at one place in different years have also revealed a variable frequency of migration (cf. Otterlind, 1961, 1978).



In the Gdansk Bay, a high abundance of Rügen-type herring in the spawning stage and with *Anisakis* larvae during the spring of 1974, to a greater extent than on some earlier occasions (Strzyżewska & Popiel, 1974), demonstrates the mobility of this westerly population.

As the Rügen-herring type and the Kattegat spring-spawning herring live in the transitional areas between the Baltic and North Seas, large variations in behaviour can be expected, especially around the Belts and in Öresund, from one year to the next. Passive transport of herring larvae and very young fish from the Baltic towards the Kattegat is a possibility, and another is active immigration there. Also conceivable are movements in the opposite direction. A comparison lying close to hand is the relationships of different cod populations in these areas (cf. Otterlind, 1984b).

The lack of herring fishery during the winter half-year before the 1970s, together with the use of small mesh-sizes, was mentioned above as the main reason why the adult Rügen-herring previously received little or no attention on the Swedish side. This explanation may also be supported by the abundant catches at Rügen, for example in the early 1950s and middle 1960s (cf. Biester, 1979), when the herring fishery - such as it then was conducted - gave low quantities in Öresund (cf. Fig. 2). The average length of herring in the non-selective fyke-net catches of Rügen, according to the same author, has not changed either way during the period 1888-1977.

The population development has differed in part between the Belts and the Rügen area. In the former, a decline took place during the first half of the 1970s (Weber, 1977), while the herring stock around Rügen developed oppositely (Biester, 1979). This might possibly be explained by a change of spawning area - remember the occurrence in the Gdansk Bay! Changes in regard to spawning areas and migration habits may, of course, have contributed to the increased Swedish catches of adult Rügen-herring in Öresund and the Baltic, which coincide with the growth in stock at Rügen during the 1970s.

The shallow waters on both sides of Rügen are undoubtedly very suitable for herring spawning, in particular those on the island's southeast side (cf. Biester, 1979). This is probably even more true for the production of herring larvae, chiefly in view of the sheltered location and the consequently stable environment and good access to food.

Conditions are otherwise in most of the waters around the Belts, in Öresund, and at the Scanian coast. Strong, shifting currents and rapid exchange of water, due for example to changing wind directions, are common. They can spread the newly hatched larvae into water areas with low nourishment in the open sea. There is reason to suspect that the spring occurrence of herring at the open Scanian south coast often leads to an "abortive spawning" without effective recruitment.



### Meristic characters and migration

In this connection we should recall the similarities in meristic characters between the Rügen type herring and the Kattegat spring-spawners. The areas of spawning and larval development, e.g. southeast of Rügen and in the Kattegat, have different hydrographic conditions, which can influence the characters in question. The explanation of the similarity may just be a mixing of the populations at diverse levels (larvae, young and/or old fish) between neighbouring and/or areas far away. Such a mixing is counteracting the creation of stable environmental-bound as well as genetical characters.

What has been said about variations as to migration and passive transportation of fry is, of course, in favour of this explanation. And so are the Swedish tagging results - in principle. However, there may be some additional or other explanation of the meristic similarity between the two herring populations. For the moment the problem is left to the reader's consideration and to future tagging experiments and studies of the spawning localities.





Fig. 1. Main migration routes of the Rügen-herring to and from the Rügen-area, left: in late autumn-winter, right: in late spring-early autumn. (Jönsson, 1981, from Jönsson & Biester, 1981.)

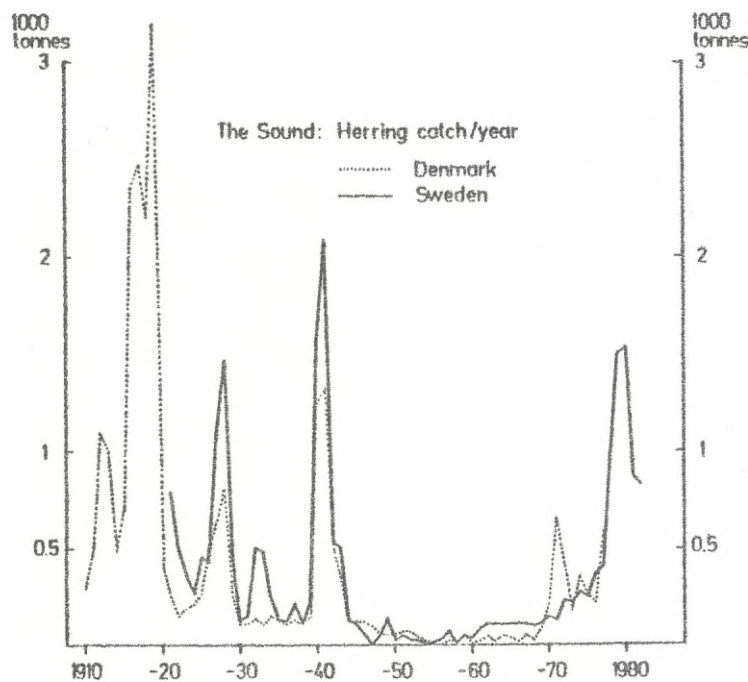


Fig. 2. Herring catches in Öresund. The data are approximate but give a correct, general picture. Periods with maximum catches: 1912-13, 1916-20, 1927-28, 1940-41 and 1978-81. These largely reflect good herring stocks, although until the 1940s mainly of autumn-spawning herring (according to the literature). It should be noted that the three highest maxima coincide with two world wars and with a period of banned herring fishery in the North Sea, thus with times of great fishing efforts in Öresund. Despite the ban on trawling here by Danish-Swedish agreement, such fishing occurs in a small area at the northern mouth which is not covered by this agreement - but which does belong to the Intern. Baltic Sea Fishery Commission's statistical area, a fact that has made comparisons difficult in recent years. (Fig. partly after Bagge & Jensen, 1967, and Bagge, 1980.)



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