

## THE TIDES IN THE STRÖMMA SOUND

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## A b s t r a c t

Regular changes in the direction of the current in the Strömma sound occurring four times a day indicate that they are the consequence of semi-diurnal tides. The character of the tides in the sound is therefore examined on the basis of tidal records made during a period of approximately one month.

It has been known for a long time that a regular change in the direction of the current occurs in the Strömma sound ( $60^{\circ}11' \text{ N.}$ ,  $22^{\circ}53' \text{ E.}$ ), which is the narrowest spot between the mainland of Finland in the east and the large island of Kimito or Kemiö in the west (*Cf.* map, Figure 1). The fact that the changes occur four times a day distinctly indicates that they are connected with the semi-diurnal tide-generating forces.

In several papers concerning the tidal phenomenon in the seas bordering on Finland, WITTING [3] and the author [1, 2] have shown that there are only weak tides in the northern parts of the Baltic Sea, the Gulf of Bothnia and the Gulf of Finland. The latter researches showed, for instance, that the intensity index, i.e. the sum of the amplitudes of the four principal tidal components ( $M_2$ ,  $S_2$ ,  $O_1$  and  $K_1$ ) varies for the Finnish tide gauges between 17 and 66 mm. The lowest values are noted in the southern part of the Gulf of Bothnia, while the highest values are characteristic of the eastern part of the Gulf of Finland. The two diurnal tides have, as a rule, a larger amplitude than the two semi-diurnal tides and the consequence is thus that the predominant

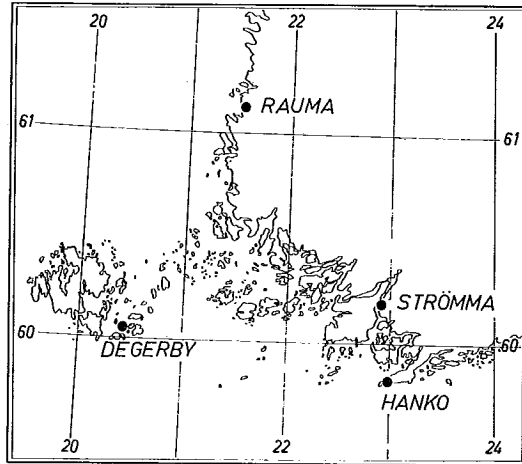


Fig. 1.

type of tidal sea level variations along the Finnish coast is diurnal. Only in the south-western part of the country have we tides of a mixed type.

It is therefore an interesting problem to investigate whether the tidal sea-level changes in the Strömme sound form an exception to the general rule. For this purpose a portable recording tide gauge was installed by the Finnish Hydrological Office on the shore of the sound and operated for a period of approximately one month. During this period there were only a few fairly short interruptions in the records. The data were kindly forwarded to the Institute of Marine Research for further investigation.

Table 1. The harmonic constants for Strömme, Degerby, Hanko and Rauma. (The amplitudes  $H$  are given in mm, the phase angles  $\alpha$  refer to the Finnish Standard time = GMT + 2h).

	Strömme 28. IV – 26. V. 1965		Degerby 1933–35		Hanko 1932–35		Rauma 1933–35	
	$H$	$\alpha$	$H$	$\alpha$	$H$	$\alpha$	$H$	$\alpha$
$M_2$	16.1	243°	7.0	249°	8.8	243°	5.3	328°
$S_2$	7.4	198°	3.6	270°	4.4	258°	2.9	354°
$O_1$	4.2	333°	4.3	86°	9.3	30°	3.7	151°
$K_1$	4.0	41°	5.1	150°	6.9	66°	5.1	207°

The harmonic analysis of the records concerned gave the following results presented in Table 1 with the corresponding data for Degerby, Hanko and Rauma for comparison. The harmonic constants for Degerby and Rauma are based on the data recorded during the years 1933—35, those for Hanko refer to the four-year period 1932—35.

Even a glance at the data in Table 1 shows that the results for Strömme differ considerably from those for the other tidal stations. This applies principally to the amplitudes. Of course, some of the deviations can be ascribed to the relative shortness of the recording period for Strömme, which may accentuate the effect of meteorological disturbances upon the sea-level records. However, it may be assumed that the main features of the differences are more or less substantial. To begin with, it may be mentioned that the intensity index for Strömme is 32 mm, being slightly lower, 29 mm, for Hanko, but 20 mm for Degerby and only 17 mm for Rauma. Concerning the type index, indicated by the ratio between the two diurnal and two semi-diurnal waves, the deviations are still more pronounced. The following results may be quoted:

Strömme	0.35,
Degerby	0.89,
Hanko	1.23,
Rauma	1.05.

We note immediately that the tides in the Strömme sound are of a different type than at the three remaining stations. The deviations are the consequence of the fact that the semi-diurnal tidal components  $M_2$  and  $S_2$  are approximately two to three times more pronounced in the sound than at the neighbouring tide gauge stations. However, even in the cases where the two semi-diurnal waves coincide the difference between high and low water amounts to only 47 mm. If the influence of the two diurnal tides  $O_1$  and  $K_1$  considered in this paper reinforces the height difference, this increases to approximately 55 mm.

It seems appropriate to attempt to incorporate the phase angles determined for Strömme sound into the general scheme of the tides in the Baltic and its large northern gulfs. Compared with the other three stations considered in this paper, the best correspondence could be expected with Hanko, as the distance between this station and the Strömme sound is the shortest. In fact, the agreement is absolute concerning the  $M_2$  tide. Whether in addition to the tidal phenomenon characteristic of the Gulf of Finland and the Baltic proper, there is

also a contribution from the Gulf of Bothnia is difficult to decide, but this possibility must always be kept in mind concerning this tide as well as the other waves. The deviation of  $60^\circ$  between the values for the phase angle for  $S_2$  for Hanko and Strömme is somewhat too large to be accepted without reserve. However, the number of days used for the determination of the harmonic constant for Strömme was not sufficient for the computation of the  $S_2$  tide, which may have led to inexactitude in the results. Moreover, the harmonic constants for the  $S_2$  tide determined by means of data for a short period, are usually affected by the  $K_2$  tide which, although weak, does exist in the Baltic.

Passing over to the diurnal tides we note that the extreme values of the  $O_1$  tide and the  $K_1$  tide occur earlier at Strömme than at Hanko. Concerning the former of these tides the angle deviation amounts to  $57^\circ$ , or almost 2 hours, whilst for the latter it is  $25^\circ$ , corresponding to a time span of 50 minutes. The data available at the present time are not adequate to allow a study of the factors which cause these differences. It is possible, however, that there is a separate tidal oscillation in the sounds between the Finnish mainland and Kimito, in addition to a co-oscillation with the adjacent sea basins.

#### REFERENCES

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