SHIP-BUILDING IN THE *YUKTIKALPATARU* AND *SAMARĀṄGANA SŪTRADHĀRA*

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From the earliest times the Indians were able to make long voyages on the Indian ocean and had made their settlements in distant islands. That they had achieved a high standard in the technique of their ship-building is proved not only from the accounts of the foreigners but also from one surviving indigenous Sanskrit text namely *Yuktikalpataru*, whose authorship is attributed to King Bhoja reigning in the eleventh century A.D., in Dhara (modern Dhar of Central India). The *Yuktikalpataru* deals with the characteristics of varieties of woods best suited for the construction of ships, the classification of vessels for river-going (*sāmānya*) and sea-going (*viśeṣa*) and their names and respective measurements etc. No thorough translation of the work is so far available. An attempt has been made in this article to prepare a thorough English translation of the original Sanskrit *ślokas* of the two chapters namely *Niṣpadayānoddeśa* and *Jaghanya Jalayānāni* dealing with the ship-building in addition to their explanatory notes.

From the dim past the Indians were able to make long voyages on the Indian ocean and made their settlements in distant islands. In the early Sanskrit texts i.e. *Vedas*, *Jātakas*, Panini's *Aṣṭādhyāyī*, epics, *Arthaśāstra* etc. there are innumerable references to sea-voyages and sea-borne trade. But the most surviving indigenous record throwing enormous light on the ship-building in India is the *Yuktikalpataru*[1] (the wishing tree of artifices). Its authorship is attributed to King Bhoja reigning in the eleventh century A.D. in Dhara, i.e. modern Dhar of Central India (though there are controversies about it). King Bhoja is well-reputed both in literature and history as an erudite scholar and the author of many valuable works such as *Samarāṅgana sūtradhāra* (architecture), *Rājamārtaṇḍa*, *Sarasvatīkaṇṭhābharṇa*, *Subhāsitaprabandha* etc. The *Yuktikalpataru* deals with the subject of ship-building elaborately in two chapters entitled *Niṣpadayānoddeśa* and *Jaghanya Jalayānāni* under the following heads: (*a*) seasons or periods suitable for ship-building; (*b*) varieties of woods best suited for the construction of ships; (*c*) Bhoja's injunction regarding the tying of iron nail to a sea-going vessel; (*d*) classification of ships—river-going or ordinary (*sāmānya*) and sea-going or special (*viśeṣa*); (*e*) names and measurements of ordinary (*sāmānya*) type of vessel; (*f*) two types of special (*viśeṣa*) ship—*dīrghā* (according to length) and *unnatā*

(according to height) (*g*) names and measurements of *dīrghā* type of ship; (*h*) Bhoja's view about *dīrghā* type of ship; (*i*) names and measurements of *unnatā* type of ship; (*j*) Bhoja's opinion about *unnatā* type of ship; (*k*) painting of ships; (*l*) decoration of ship; (*m*) ships with cabins (*n*) characteristics of royal ship according to Bhoja (*o*) despicable water vessels (*jaghanya jalayānāni*). No translation of the *Yuktikalpataru* is so far available. Dr. R. K. Mookerji while discussing the history of the sea-borne trade and maritime activity of the Indians from earliest times in his *Indian Shipping*[2] has referred to some *ślokas* of the *Yuktikalpataru* though not thoroughly.

The *Samarāṅgana Sūtradhāra*[3] is a work on architecture of human dwellings, palaces, the planning of towns and villages etc. Its thirty-first chapter entitled *atha yantra vidhāna nāmaikatriṃśo' dhyāya* contains descriptions of various kinds of mechanical contrivances (i.e. *yantra*) such as elephant machines (*gajayantra*), wooden bird-machine travelling on the air (*vyomacāri-vihaṅga yantra*), wooden *vimāna* machine flying in the air (*ākāśagāmīdārumaya vimāna yantra*) etc. The *Samarāṅgana* defines *yantra* as machine which controls the *bhūtas* and make them serve a specific purpose, that is, it directs and controls according to a plan, the motion of things that acts upon each other according to its own nature. The essential factors or elements of *yantra* according to the *Samarāṅgana* are four—the earth, water, fire and wind and it states the three varieties of *yantra—jala-yantra āgneya-yantra* and *vāyu-yantra*. In this paper discussion has been made only on *jala-yantra*.

The English translations of the two chapters of *Yukti-kalpataru* with their sanskrit *ślokas* are first given below :

atha niṣpadayānoddeśaḥ

"Then comes the un-wheeled vehicle"

naukādyaṃ niṣpadaṃ yānaṃ tasya lakṣaṇamucyate //79//
aśvādikantu yad yānaṃ sthale sarvaṃ pratiṣṭhitaṃ
jale naukaiva yānaṃ syādata stāṃ yatnatovahet //80//

(*a*) THE SEASON FOR THE SHIP-BUILDING

atha kālaḥ

suvāra velā tithi candra yoge,
care vilagne makarādi ṣaṭke /
rikṣe' ntya saptasvatirekato'nye ;
vadanti naukā ghaṭanā (kā) dikarma //81//
aśikharāṅśu sudhānidhi-pūrvā.
mitra dhanācyutabhe (te) śubhalagne /
tāraka yogatithīndu viśudhau /
naugamanaṃ śubhadaṃ śubhavāre //82//

"Signs of the un-wheeled vehicle is stated to be shiplike. Horse-like conveyances on land are all established facts. If the vehicle in water be ship-like it should be steered in it with care. Time to be selected for ship-building is said to be in, auspicious day, hour, *tithi* and moon, when the Mars is in the sixth from the capricorn and other *rāśis* when the last (star) of the constellation of the seven stars (Great Bear) transits from one position to another.

Voyage of the water-going vessels on auspicious days, when the moon is in the eastern horizon whose beams have not yet reached zenith, when sun conjoins with *dhaniṣṭhā* in its displaced position and there is conjunction of pure star, moon and *tithi* is beneficial".

(*b*) Woods for the Construction of Ship

vṛkṣāyurveda gaditā vṛkṣājātiścaturvidhā /
samāsenaiva gaditaṃ teṣāṃ kāṣṭhaṃ caturvidhaṃ //83//

tad yathā /

laghu yat komalaṃ kāṣṭhaṃ sughaṭaṃ brahmajāti tat /
dṛḍāṅgaṃ laghu yat kāṣṭhamaghaṭaṃ kṣatrajāti tat //84//
komalaṃ guru yat kāṣṭhaṃ vaiśya jāti taducyate /
dṛḍāṅgaṃ guru yat kāṣṭhaṃ śūdrajāti taducyate /
lakṣaṇadvayayogena dvijātiḥ kāṣṭhasaṃgrahaḥ //85//
kṣatriya kāṣṭhairghaṭita bhoja mate sukhasaṃpadaṃ naukā /
anye laghubhiḥ sudṛḍaiḥ bidadhati jaladuṣpade naukāṃ //86//
bibhinnajātidvaya kāṣṭhajātā na śreyase nāpi sukhāya naukā /
naiṣā ciraṃ tiṣṭhati pacyate ca bibhidyate bāriṇi majjate ca //87//

"In the *Vṛkṣāyurveda* (the Science of Plant life) it is stated that there are four types of trees which have their four varieties of woods altogether; such as *brahmajāti*—the wood which is light, soft and can be easily joined; *kṣatrajāti*—the wood which is light, hard and can not be joined; the wood which is soft and heavy and the wood which is hard and heavy are respectively called *vaiśya* and *śūdrajāti*.

The wood of mixed-class consists of two (separate) properties. According to Bhoja a ship constructed with the wood of the *kṣatriya* class brings wealth and happiness. According to others the ship made of light and hard wood is capable of passing through troubled waters. The ships made of two different kinds of wood bring neither good nor comfort. They do not last for a long time, rot, split and sink in the water".

(*c*) The Tying of Iron-nail to a Sea-going vessel

na sindhugādyārhati louha bandhaṃ,
talloha-kāntaiḥ hṛyate hi louhaṃ /
vipadyate tena jaleṣu naukā ;
guṇena vandhaṃ nijagāda bhojaḥ //88//

"Bhoja enjoined that iron should not be tied to a sea-going vessel by means of a string because that iron may be attracted with magnetic iron in the sea and may cause danger".

(*d*) CLASIFICATION OF SHIPS—*Sāmānya and Viśeṣa*

atha lakṣaṇāni /
sāmānyañca viśeṣaśca naukāyā
lakṣaṇadvayaṃ //89//

"Then comes the classification (of ships)—*sāmañya* (ordinary) and *viśeṣa* (special) are two classes of ships".

(*e*) NAMES AND MEASUREMENTS[4] OF THE *Sāmānya* (ORDINARY) TYPE OF VESSELS

tatra sāmānyaṃ /
rājahastamitāyamā tatpāda pariṇāhinī /
tāvadevonnatā naukā kṣudreti gaditā budhaiḥ //90//
ataḥ sārdhamitāyāmā tadardha-parināhinī /
tribhāgenotthitā naukā madhyameti pracakṣate //91//
kṣudrātha madhyamā bhimā capalā paṭalā 'bhayā /
dīrghā patraputā caiva garbharā mantharā tathā //92//
naukā daśakamityuktaṃ rājahastairanukramaṃ /
ekaika vṛddhaiḥ (vuddheḥ) sārddhaiśca vijānīyāt dvayaṃ dvayaṃ //93//
unnatiśca pravīṇā ca hastādardhaṃśa-sammitā /
atra bhīmā 'bhayā caiva garbharā caśubhapradā //94//
mantharā parato yāstu tāsāmevāmbudhaugatiḥ /
tāsāṃ gunastu saṃkṣepat dṛḍatā ca prakirṇatā //95//

"Ordinary (*sāmānya*) type comprises :

The ship whose length is like one *rājahasta*, breadth one-fourth and the height is just the same (of the breadth) is called *kṣudra* by the wise.

The ship whose length is one and half of the *rājahasta*, the breadth half (of the length) and the height one-third, is called *madhyamā*. The ten types of ships are—*kṣudra* (diminutive), *madhyamā* (moderate), *bhīmā* (formidable, tremendous), *capalā* (moving to and fro), *paṭalā* (with covering), *abhayā* (not dangerous) *dīrghā* (tall), *patraputā* (like that of cup made of leaf folded or doubled) *garbharā* (with inner compartments) and *mantharā* (curved).

The respective measurements of the length of the ten ships should be known as one (*rājahasta*), increment of the same by its half, increment of the same by its same and so on alternately and those of their height and breadth are half of the said-length.

Bhīmā, abhayā, garbharā bring ill-luck. Besides *mantharā*, the rest are sea-going vessels and as regards their merits, they are, briefly speaking, endurable and spacious".

(*f*) TWO TYPES OF SPECIAL (*Viśeṣa*) SHIP *Dīrghā and Unnatā*

atha viśeṣaḥ /

louhātāmradipatreṇa kāntalohena vā tathā /
dīrghā caivonnatā ceti viśeṣa dvividhā bhidā //96//

"Then comes special (*viśeṣa*) type of ship—special vessels, made of the foil of iron and copper etc. or of load-stone are of two types—according to length (*dīrghā*) and height (*unnatā*)".

(*g*) NAMES AND MEASUREMENTS[5] OF *Dīrghā* TYPE OF SHIPS

tatra dīrghā yathā

rājahasta dvayāyāmā aṣṭāṃśa-pariṇāhinī /
naukeyaṃ dīrghikā nāma daśāṅkenonnatāpi ca //97//
dīrghikā taraṇirlolā gatvarā gāminī tariḥ /
jaṅghāla plāvinī caiva dhāriṇī veginī tathā //98//
rājahastaikaika vṛddhā (dvyā) noukānāmāni vai daśa /
unnatiḥ pariṇāhaśca daśāṣṭamśaṃitau kramāt //99//
atra lolā gāminī cn plāvinī duḥkhada bhavet /
lolāyā mānamārabhya yāvadbhavati gatvarā //100//
lolāyāḥ phalamādhatte evaṃ sarvāsu nirṇayaḥ /
veginyāḥ parato yā tu sā śivāyottarā yathā //101//

"The ship according to length (*dīrghā*)—the vessel whose length is two ***rājahastas*** breadth one-eighth (of its length) and height one-tenth (of its length) is called *dīrghikā*. The names of the ten ships are : *dīrghikā* (tall), *taroṇī*, *lolā* (moving hither and thither) *gatvarā* (perishable), *gāminī* (going and moving on), *tari*, *jaṅghālā* (running swiftly), *plāvinī* (flowing over), *dhārinī* (power of possessing), *veginī* (having velocity) ; each of whose length is increased by one *rājahasta* in arithmetic progression and each of whose height and breadth are one-tenth and one-eighth of the same (length) respectively. Then *lolā*, *gāminī* and *plāvinī* bring ill-luck ; so also *gatvarā* follows the example of *lolā*. All the rest are beset with the same evils. Besides all these *veginī* is also opposed to good-luck".

(*h*) BHOJAS VIEW ABOUT *Dīrghā* TYPE OF SHIPS

bhoja 'pi,—

noukā dīrghaṃ yathecchaṃ syāt tatraitāni vivarjayet /
hasta saṅkhyā parityājyā vasuveda grahottare //102//
sasthyuttaramitā naukā kulaṃ hanti valaṃ dhanaṃ /
navateruttare yāpi yā catvāriṃśateḥ parā //103//
atena catvāriṃśat saṣṭhi navati sankhyā tatatparato 'pi /
yāvadaparadaśakaṃ tāvadeva tat phalamiti //104//

iti dīrghā /

"Bhoja also says (about *dīrghā* type of ships)—though the length of the ship may be made according to desire it should be restricted to the numbers of the two hands, eight *vasus*, four *vedas* and nine *grahas* (planet). Ships more than ninety, sixty and forty cubits long bring about destruction of family, strength and wealth. Not only forty, sixty and ninety cubits long ships but also the ships of other lengths share the same fate with the other types of ten ships.

The end of *dīrghā* type".

(*i*) Names and Measurements[6] of *Unnatā* Type of Ship

yathonnatā //

rājahastadvayamitā tāvat prasaranonnatā /
iyomūrdhvābhidhā noukā kṣemāya prithivī-bhujāṃ //105//
ūrdhvānurdhvā svarṇamukhī garviṇī mantharā tathā /
rājahastaikaika vṛdhvyā nāma pañcatrayaṃ bhavet //106//
atrānurdhvā garviṇī cad ninditaṃ nāma yugmakaṃ /
mantharāyāḥ parā yāstu tāḥ śubhāya yathodbhavaṃ //107//

"Then comes the ship according to height (*unnatā*). Ships with two *rājahastas* in length and so also the breadth and the height —such vessels, according to height (*unnatā*), bring goodluck to the king of the world. *Urdhvā* (elevated), *anurdhvā* (non-elavated), *svarṇamukhī* (good-faced), *garvinī* (power of being filled with) *mantharā* (slow-going) are the names of the five ships with each of their length increased by one *rājahasta* in arithmetic progression. The couple of *anūrdhvā* and *garvinī* with *mantharā* indicate ill-fame. The rest (*svarṇamukhī*) brings good-luck".

(*j*) Bhoja's Opinion About *Unnatā* Types of Ship

bhoja 'pi
vaṇāgnuttarato mānaṃ noukānāṃ śubhaṃ vahet /
pañcāśadūrdhvadullasaṃ dhananāśaṃ trayo'rdhataḥ //188//
ityunnatā.

"Bhoja also says :

Ships whose height is more than three *agnis* and five *vāṇas* (i.e. thirty-five cubits) bring prosperity and those more than fifty (cubits) bring joy but those half or two-third of that (fifty cubits) cause misfortune.

Ends of *unnatā*".

(*k*) Painting of the Ship

dhātvādīnāmato vakṣye nirṇyaṃ tarī-saṃśrayaṃ /
kanakaṃ rajataṃ tāmraṃ tritayaṃ vā yathā kramaṃ //109//
brahmādibhiḥ parinyasya noukā citraṇa-karmaṇi /
catuḥ śṛṅgā triśṛṅgādhā dviśṛṅga caikasṛṅginī //110/

sitaraktāpītanīlavarṇān dadyāt yatha-kramaṃ /
keśarī mahiṣo nāgo dvirado vyāghraeva ca //111//
pakṣī veko manuṣyaśca eteṣāṃ vadanāṣṭakaṃ /
navāṃ mukhe parinyasya ādityādi-daśā-bhuvaṃ //112//
kalaso darpaṇaścandrastraidaśānaṃ mahībhujāṃ /
haṃsaḥ kekī śukaḥ siṃho gajo'hi-vyāghra ṣaṭpadau //113//
ādityādidaśa jāta (tā) noukopari parinyaset /
catustritvaika vimilā caturvarṇā yathākarmaṃ //114//

"Metals, which are used in ships, are mentioned as gold, silver, copper and the compound of all these three. Brahma and other Gods recommend that in the art of painting the ships, those with four-masts three-masts, two-masts and one-mast should be coloured with white, red, yellow and blue respectively. On the prow eight faces such as those of lion, buffalo serpent, elephant, tiger, bird) frog and man should be depicted but on the body of the ship the picture of celestial bodies such as those of the sun etc. pitcher, mirror, the moon, heavenly kings like Indra etc. swan, peacock, parrot, lion, elephant, serpent, tiger and two bees should be painted after smearing the ship with fourth (white), third (red), second (yellow) and first (blue) colours in due proportion one after another".

(*l*) Decoration of Ship

ācchādanaṃ catuṣpāte kamalā nāma kathyate /
tat saṃkhyāśatapade me tadardhārdhamivāparāt //115//
śuklaraktotha citraśca pītaḥ kṛṣṇastribhistribhiḥ /
avajñāsikasamjñānām vastra varṇaṣṭakaṃ viduḥ //116//
noukāsu maṇivinyāso vijñeyo navadaṇḍavat /
muktāstavakairyuktā noukā syāt sarvatobhadrā //117//
tat saṃkhyā cedatha rasaveda-dvaya sammitā kramasaḥ /
kanakādīnāṃ mala (mano) jaymāleti gadyate sadbhiḥ //118//

"The ship, whose four-sides are wrapped with thin sheets of metal and whose length is one-fourth of one hundred (twenty-five), whose breadth is half of its length (twelve and half) and whose height is half (six and one-fourth) of its breadth is called by the name *kamalā*. The eight colours of the kind of *avājñāsika* cloth should be known as being composed of white red spotted yellow and black colours mixing three in each case respectively. The ships besetted with pearls, resembled the umbrella of *navadaṇḍa* type. Such pearl-bedecked ships always bring good-luck. The number of the bunch of pearls bedecking the ship should be two, four (*vedas*), and six (*rasas*) respectively. Honest people call the gold-necklace of the ship as the garland of victory".

(*m*) Three Types of Ships with Cabins

brahmakṣatre dvitaye ekaike vaiśyaśūdra yonī
nirgṛham sagṛham vātha tatsarvaṃ dvividhaṃ bhavet //119//

nirgṛhaṃ pūrvamuddiṣṭam sagṛhāṇi yathā (ca) śṛṇu /
sagṛhā trividhā proktā (nnoktā) sarvamadhyāgramandirā //120//
sarvato mandiraṃ yatra sā jñeyā sarva-mandirā /
rājñāṃ keśaśvanārīṇāṃ yānamatra praśasyate //121//
madhyato mandiraṃ yatra sā jñeya madhyamandirā /
rājñaṃ vilāsa-yātrādi (traṃ) varṣasu ca prasaśyate //122//
agrato mandiraṃ yatra sā jñeyā tragramandirā /
cirapravāsa yātrāyam raṇe kāle ghanātyaye /
mandira (rā) mānam noukā prasarata evārdha bhāgato nyunāṃ //123//

"Ships, *brahma*, *kṣatra*, *vaiśya* and *śūdra*, are of two types—with cabins and without cabins. The description of ships without cabins has already been menttioned. Now hear about the ships with cabins. Ships with cabins are of three kinds—*sarvamandira*, *madhyamandira* and *agramandira*. The ship having cabin extending from one end to other is called *sarvamandira* and it is for the transport of royal treasure, horses and women. The ship having a cabin in the middle is called *madhyamandira* and it is suitable in the rainy season and for pleasure trips of kings. The ship having a cabin in the front is called *agramandira* and it is convenient in the dry seasons without rains, for long voyages and naval warfare. The ship having a cabin less than half of its length becomes swift in speed".

(*n*) Characteristics of the Royal Ship According to Bhoja

bhoja stu

dīrghavṛtta vasuṣaṭ—divākarāneka—diṅgnavamitā yathākramaṃ /
rājapañcabhujasammitonnatirmandire tarigate mahībhujāṃ //124//
bhāskarādika-daśabhuvāṃ punardhātu nirṇayanamatra pūrvavat /
patākākalasādināṃ nirṇayo navadaṇḍavat //125//
kaṣṭhajaṃdhātujañceti mandiraṃ dvividhaṃ bhavet /
kaṣṭhajaṃ sukhasampattyai vilāse dhātujaṃ mataṃ //126//
atha śayyāsanādīnāṃ mantharollocayorapi //
anyeṣāñcaiva munibhi nirṇayaḥ pūrvavanmataḥ //127//
diṅgmātramidamuddhiṣṭam naukālakṣaṇamagrajaṃ //
pradhāneśveva niyamojapradhāne na nirṇayaḥ //128//
laghutā dṛḍatā caiva gāmitājchidratā tathā /
samateti guṇoddeśo naukānāṇi (yāṃ) samprakāśitaḥ //129//
evāṃ vicintya yo rāja noukāyānāṇi karoti ca (hi) /
sa ciraṃ sukhomāpnoti vijayaṃ samareśriyaṃ //130//
yo' jñānādanyathā yānaṃ noukanaṃ kurutenṛpaḥ /
tasyaitāni vinaśyanti yaśo viryaṃ valaṃ dhanaṃ //131//

iti niṣpadayānoddeśa noukā—yānaṃ.

"The royal ship should be oval and the measurements of the heights of its cabin (should be) six, eight (*vasus*), nine, ten (the many directions), twelve (*divākaras*) and five *rājahastas* (cubits) respectively. The picture of the celestial bodies such as those of the suns etc. should be depicted in the royal ship with the aforesaid metal and those of the flags and pitchers etc. should be like the aforesaid *navadaṇḍa*. The cabin of the royal ship may be of two kinds—wooden conducive to prosperity and happiness and metallic for pleasure. The decoration with the bedsteads, seats, etc. and also curved canopy and other furniture should be as aforesaid stated by the sages. These are the peculiarities of the principal type of ships only and the ordinary ships deserve no mention. Lightness, hardness, mobility hollowness and good-proportion—these are known to be the attributes of the ships. The king who builds his ship after considering all these, enjoys happiness throughout his whole life and gains victory in war. The king who builds the ship otherwise out of his ignorance, his reputation, strength force and wealth are all destroyed.

Here ends the account of un-wheeled vehicle".

(*o*) Despicable Water-vessels (*Jaghanya Jalayānani*)

yatho jaghanya jalayānāni /

yathā —

noukānyato jale (sya) yānaṃ jaghanyamiti gadyate /
taddehā vahavaste tu pāścātyānāṃ prokirtitaḥ //132//
droṇīrūpantu yadyānaṃ dronīyānaṃ taducyate /
ghaṭī (ta) bhirghatitaṃ yānaṃ ghaṭī nouketi gadyate //133//
tumbyādyaistuphalairyānaṃ phalayaṃpracalṣate /
carmabhiḥ sthū (stu) lapūraṇaiyarccarma-yānaṃtaducyate //134//
yānaṃyallaghubhirvṛkṣaivṛkṣa—yānāntaducyata /
jantubhiḥ salile yānaṃ jantuyānaṃ pracakṣate /
vāhubhyāṃ santaredvāri jaghanyeṣu tadnirṇayaḥ //135//
śrībhojarajīya yuktikalpatarau niṣpadayānoddeśaḥ /
iti śrimahārāja bhojarāja-viracito yuktikalpataru samāptaḥ //

"Then come *Jaghanya* (despicable) water-vessels such as,—vessels other than ships (aforesaid) and those of the western people, which are said to have many shapes, are called despicable ; they are :

droṇi (pitcher)-vessels having the shape of *droṇi*,

ghaṭi (waterpot)-vessels built in the shape of *ghaṭi*,

phala-yānaṃ (fruit-vessels)—vessels constructed with the vind of gourd and the like,

carma-yānaṃ (leather-vessels)—vessels made of thick leather,

vṛkṣayānaṃ (tree-vessels)—vessels constructed with light trees,

jantu-yānaṃ (animal vessels)—conveyance through water by means of animals.

The art of swimming does not fall within the despicable category.

Here ends the accounts of un-wheeled-vehicle of the *Yuktikalpataru* of King Śrī Bhojarāja[4].

Regarding *jalayantra*[7], the *Samarāṅgana Sūtradhāra* states thus :

kāṣṭham (bhṛ ? kṛ) ttiśca loham ca jalaje pārthivam bhavet /
anyadambhastadanyastu tiryagūrdhvamadhastathā //33//
vījam svakīyam bhavati yantreṣu jala-janmasu /
tāpādyam pūrvakathitam vahnijam jalaje bhavet //34//
saṃgṛhītaśca dattaśca pūritaḥ pratinoditaḥ //
marud vījatvamāyāti yantreṣu jala janmasu //35//

"For a *jala-yantra* (the use of) timber, hide and metal like iron etc. form the earthly (*pārthiva*) element, other water and its own water in upward, downward and oblique direction its own watery element, heating etc. as aforesaid its fiery element and air-conditioning, i.e. gathering (*saṃgṛhīta*), imparting (*datta*), filling (*pūrita*) and impelling (*protinodita*) form the airy element".

Though it is not definitely stated here that this machine *jala-yantra* refers to any boat or ship but from the context about the relating *vāyu yantra* whose description undoubtedly refers to flying machine (air-ship) the description of *jala-yantra* might as well be assumed to refer to boat and ship or more probably refer to craft moving under the surface of water (submarine) as the collection, storage etc. of air seem to suggest.

Notes and References

1 *Yuktikalpataru* (Edited) Iswara Chandra Sastri.

2 Mookerji, R. K. *Indian Shipping*, Bombay, 1912.

3 *Samarāṅgana Sūtradhāra* (Edited)—T. Ganapati Sastri, 2 Vols., 1924 and 1925, Baroda 31.

4 The term *rājahasta* literally means king's hand, but here it is used as fixed unit of measurement and is equivalent to 16 cubits, according to R. K. Mookerjee. The names of the ten ordinary or inland vessels (*sāmānya*) along with the measurements of the three dimensions are given below :

Name of the vessels	Length in cubits	Breadth in cubits	Height in cubits
1) *Kṣudra*	16	4	4
2) *madhyamā*	24	12	8
3) *bhīmā*	40	20	20
4) *capalā*	48	24	24
5) *paṭalā*	64	32	32
6) *abhayā*	72	36	36
7) *dīrghā*	88	44	44
8) *patrapuṭā*	96	48	48
9) *garbharā*	112	56	56
10) *mantharā*	120	60	60

[5] Sea-going or special vessels (*viśeṣa*) according to length (*dīrghā*) :

Name of the vessels	Length in cubits	Breadth in cubits	Height in cubits
1) *dīrghikā*	32	4	3
2) *taranī*	48	6	4
3) *lolā*	64	8	6
4) *gatvarā*	80	10	8
5) *gāminī*	96	12	9
6) *tarī*	112	14	11
7) *jaṅghalā*	128	16	12
8) *plāvinī*	144	18	14
9) *dhārinī*	160	20	16
10) *veginī*	176	22	17

[6] There was another sub-division of sea-going vessels according to height and is known as *unnatā* type, whose length varies from 32 to 96 cubits in multiples of 16 and the breadth and height were each half of the length, according to R. K. Mookerji, whereas in the original *śloka* their breadth and height are just the same of their length. *Sea-going or special vessels (viśeṣa) according to height (unnatā)* :

Name of the vessels	Length in cubits	Breadth in cubits	Height in cubits
(1) *ūrddhvā*	32	16 (32)	16 (32)
(2) *anūrddhvā*	48	24 (48)	24 (48)
(3) *svarṇamukhī*	64	32	32
(4) *garbhinī*	80	40	40
(5) *mantharā*	96	48	48

[7] *Samarāṅgana Sūtradhāra*, 33-35.